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THE ACTUAL PROBLEMS OF THE PANAMA CANAL.

By John F. Wallace.

PRELUDE.

As opportunity offers, the writer desires, through the medium of THE ENGINEERING MAGAZINE, to contribute a few notes from time to time on the Panama Canal, touching briefly on its history, various plans suggested for its construction, the organization and methods, and also the general features of the work. Consideration will be given to the various factors entering into the problems of administration and control, as well as to the consideration of the engineering and technical features of plan and construction.

In the consideration of the subject as a whole these various features are as essential to a comprehensive consideration of the subject as the warp and woof of a woven garment to its integrity.

INTRODUCTION.

WHEN Balboa, after being tossed for weeks and days on the troubled waters of the Caribbean Sea, landed on the Isthmian shore, fought his way through a tropical jungle to the backbone of the continental divide, and, gazing southward, perceived the comparatively calm waters of the Pacific Ocean in Panama Bay, he little dreamed of the many troubles contained in the Isthmian addition to Pandora's box, which would escape by the after suggestion of the possibilities of construction of an Isthmian canal. Men have come, and men have gone; lives, reputations, and fortunes have been sacrificed at the altar of this idol. It is to be hoped that we are now standing at last on the threshold of a consummation.

The momentum of the idea, which has lived through several centuries, and which has now been adopted and absorbed by America's largest nation, is a strong guarantee that at some time, in some

way, and at some cost, the original idea will finally be realized, although the price which is yet to be paid in lives, reputations and money, and the time required to do the work are as yet undetermined quantities.

The writer desires, through the pages of this magazine, to give the engineering profession, and the country at large, such information as he thinks will, in some measure be useful in assisting those interested to arrive at a more accurate understanding of the subject. It will be his endeavor to consider the subject from the standpoint of a disinterested and unprejudiced investigator, without fear or favor of those who may be selfishly interested politically, financially, or otherwise, eliminating all motives of malice or self interest. Although it is not to be expected that his views will meet the approval of all, he at least desires that his loyalty to his country and the sincerity of his motives will be appreciated.

HISTORY.

COMMENTS ON THE FRENCH PHASE.

While it is not desirable to go into the full details of the pathetic history of the De Lesseps project, it contains many lessons, which, even at this time, deserve careful consideration in order that the pitfalls of the past may be avoided. Frequently the greatest successes are based on gigantic failures, and the success of the few is generally achieved by a careful study and analysis of the causes that have led to the failure of the many.

No one will question either the purity nor the grandeur of De Lesseps' original conception of a sea-level canal at Panama. His failure was not due to the impracticability of his conception, or to the impossibility of its execution, even with the means at his command under ordinary conditions. His failure was brought about by the selfishness and insincerity which animated his advisers and followers, assisted by financial complications, and accelerated by climatic conditions. To what extent the American project will be hampered in this way remains yet to be seen. It will certainly be the part of wisdom to refrain from undue criticism of the past until the tale of the future is told.

The Technical Studies of the French were apparently exhaustive, and are entitled to most careful consideration by American engineers in charge of the work. Such studies supplemented by careful investigation and verification, particularly as to basic facts, will be of material assistance in arriving at proper conclusions. The elaborate preparations made by the French, and the provision for the health

and comfort of employees were certainly creditable, and in the light of sanitary knowledge available at that time, were excellent. Considering all the conditions, the amount of work actually accomplished was substantial at least, and from an engineering point of view success would have been obtained, had the moral, commercial, financial and climatic influences been less potent.

COMMENTS ON THE AMERICAN PHASE.

For the last fifty years consideration has been given to the project of an Isthmian canal by the American people. Every possible route has been investigated in a more or less imperfect way, from the tunnel project of the San Blas Route at Darien to the Ship-Railway Scheme of Captain Eads at Tehuantepec, and volumes have been written containing a mass of information and misinformation by engineers and others, some of whom have made careful examination of the various routes, and some who have never seen the Isthmus or been affected by the debilitating influences of a tropical climate; and, as usual in a consideration of important subjects, those who have known the least have been the most positive in their convictions and in the expression of their opinions, it being much easier to build theories from one's inner consciousness than to accumulate data, analyze, and deduce conclusions from the accumulation of hard cold facts.

Up to the time of the report of the first Walker Commission the complications surrounding the political and financial conditions of the Panama enterprise seemingly made the consideration of that project by the American people an impossibility; therefore American interests had been turned to other schemes, principally to Nicaragua, which seemed the most practicable. The investigations of the original Walker Commission, composed of the flower of the engineering profession of America, were confined to a consideration of the comparative merits of the various general routes proposed, and had nought to do with the detailed features of any route, beyond what was necessary to arrive at the best general proposition.

Careful consideration by this Commission resulted in the selection of the Nicaragua and Panama routes as most practicable ones. As the central feature of the Nicaragua route comprised an artificial navigable lake ninety to one hundred feet above the sea, with a flight of three locks on either side of a continental divide, approached by sea-level sections from either end, it was obvious that, in fairness for comparative purposes, a similar plan should be considered at Panama, embracing an artificial lake for the summit level at approximately the same elevation, the two schemes being thus on a similar basis.

Principally for this reason, although not so stated, it is evident that the original Walker Commission did not feel called upon to consider a sea-level project at Panama in full detail, as the physical conditions at Nicaragua render a lock canal with a summit level of approximately ninety feet imperative for that route. Consequently, the Commission, more or less wisely forebore injecting an uncertain and disturbing element into the situation by doing more than casually mentioning the possibilities of a sea-level canal at Panama at an expenditure of time and money practically double the amount estimated for the completion of either the Nicaragua or high-level Panama projects.

Using the same unit prices in its comparative estimates, the Commission found that, as a matter of physical construction, the Panama route was approximately forty-five million dollars the cheaper, considering original cost alone. While a more thorough investigation of the physical conditions at Panama might have caused the Commission to increase its estimate for that project, it naturally relied upon what seemed to be the thorough borings and investigations made by the French, supplemented by examinations of its own, considering that American engineering ingenuity and management would overcome any material increase in cost due to unforeseen difficulties, particularly as an allowance of twenty per cent to cover administration, sanitation, engineering and contingencies was included in the estimate.

At that time the uncertain financial feature was the amount for which the franchise and property of the French Company could be secured. As this amount had been fixed by the French Company at one hundred million dollars it induced the American Commission to primarily recommend the adoption of the Nicaraguan route. The common sense and Yankee shrewdness with which Admiral Walker and his colleagues handled the negotiations resulted in the French Company modifying its price to some forty million dollars, which indicated the probability of the Panama route being the most economical. This resulted in the Walker Commission reconsidering its first recommendation, and suggesting the advisability of selecting the Panama route, which was provisionally adopted by the American Congress through the passage of what is known as the Spooner Bill, appropriating the necessary money therefor, and authorizing the President to construct an Isthmian canal on either the Nicaragua or Panama route, depending on his ability to bring to a successful conclusion the negotiations with the French Company, and the consummation of a suitable treaty with the Republic of Colombia.

Admiral Walker, under the direction of the President brought the purchase of the property to a successful conclusion. This arrangement appeared to have in it the elements of justness and fairness. While the amount seemed low to the French Company it was practically its last chance to in any way recuperate itself for the large amount of money more or less wastefully expended. At the same time the American Government secured the franchise, a certain amount of physical property, and the accomplishment of some work, besides the results of years of valuable experience—in all a consideration for which it would doubtless have required an expenditure of a large amount of money, particularly had it undertaken the construction of the Panama Canal *de novo*.

Later the manipulations and finesse of the confidential agent of the Panama Canal Company brought about the birth of the infant Republic of Panama, which made it possible for the American administration to cut the gordian knot of diplomacy, and consummate the transaction, thus ending the first phase of American control of the Panama project. This latter event happened during the close of the year 1903.

The story of how a syndicate was formed to buy the control of the French Company, educated the American people to look with favor on the Panama route, and created a new national entity with which the United States could negotiate a treaty. The making of the Panama Canal even a possibility is yet to be told by those men more familiar with the history of these transactions than the writer.

THE SECOND PHASE.

In the early part of the year 1904 the Commission authorized by the Spooner Act was created by the President, with Admiral Walker at its head, and consisted of Professor W. H. Burr, a member of the old Commission, General Geo. W. Davis, B. M. Harrod, Wm. Barclay Parsons, C. E. Grunsky, and Frank J. Hecker. This Commission organized, and during April, 1904 proceeded to the Isthmus to make a preliminary investigation. General Geo. W. Davis, one of the Commission, was appointed Governor of the Canal Zone, and placed in temporary charge of the work until the appointment of a Chief Engineer. Four parties of engineers were organized, and sent to the Isthmus to begin technical investigations; one, under Mr. List, with instructions to investigate all matters relating to the harbor of Colon, and the Caribbean Sea section; a second, under Mr. Nichols, to investigate the possibilities of a dam site at Gatun; a third, under Mr. Dose, to make detailed investigations and studies of the Bohio Dam

site, and what is known as the Tiger Hill Cut-Off; the fourth, Mr. Ehle, to investigate the dam sites at Gamboa and Alhajuela, and the various questions relating to the watershed of the Chagres, with instructions to consider in detail possibilities of various spillways necessary should either the Gamboa or the Alhajuela Dam be determined on, and, incidentally, tunnel spillways either to the Pacific or Caribbean slope.

In the mean time Major Black of the U. S. Engineer Corps was placed temporarily in charge of the engineering work, and assisted by Lieut. Brooke, and Mr. Harper, Resident Engineer, was instructed to take over the French construction work, which was at that time actually in progress in a small way in the vicinity of Culebra, the summit excavation.

For approximately a year previous Major Black, assisted by Lieut. Brooke and Mr. Harper, had been stationed on the Isthmus observing the French methods, and making a general study of the work. On May 4, 1904, Lieut. Brooke, under direction of Major Black and General Davis, took over the work in accordance with instructions from Mr. Russell representing the State Department.

The writer was appointed Chief Engineer of the Isthmian Canal Commission effected June 1st, 1904. After conference with the Commission at Washington, he proceeded to the Isthmus, arriving there on June 28th. While the "Spooner Act" seemed to determine in a general way that the Canal should be constructed in accordance with the plans outlined in the Report of the original Walker Commission, providing for a lock canal with a summit level some ninety feet above sea level, including the proposed artificial Lake Bohio; the Commission desired the Chief Engineer to investigate all features of the problem, in order that the best possible plan might finally be selected.

It was understood, however, that changes in detail even to the extent of eliminating the artificial Lake Bohio, or selecting other sites for the locks and dams than those outlined in the Walker Report would be admissible under the Spooner Act, provided such changes did not increase the cost of the work over the $144,000,000 Estimated Cost as set forth in the Walker Report and provided for by the Spooner Act.

The work under the Chief Engineer was divided under two general heads.

1st. *The Technical Studies*—(a) To determine the practicability of the plans and alternate details of plans recommended for consideration by the first Walker Commission.

(b) To determine by examination, study and verification of the French data supplemented by original investigation of all possible factors affecting the problem, to the end that no question might in future be raised as to the wisdom of the adoption of whatever plan might be finally selected.

2nd. *Construction*—Under normal conditions construction work should only follow the most complete and thorough study of all the elements of the scheme under consideration. Considering the magnitude of the problem the Panama Canal has been remarkable in the vast amount of inaccurate or partial information which has heretofore preceded the expenditures of such large sums of money as will be necessary to successfully accomplish the desired result.

When the United States came into possession of the Panama Canal, construction work was being carried forward at the "Culebra Cut," the summit excavation, at the rate of about one thousand cubic yards per day, approximating some 25,000 cubic yards per month, costing sixty-five cents per yard according to the claim of the French Co.; but, estimating on the basis of Mayor Black's report of yardage removed under his observations, the cost averaged nearly eighty cents per yard. The material being removed consisted of all the various classes constituting the Culebra soft yellow clay, underlying which was hard basaltic rock under the main divide, flanked to the northward by soft rock, shales and clays.

The work was largely hand labor, the use of machinery having gradually been discarded on account of its worn out condition. The organization under the direction of the French Director of Works consisted of such a staff in field and office as was needed to supervise the working force at Culebra which consisted of about five hundred men, superintendents, foremen, clerks, and laborers—mostly Jamaica negroes, but with some French, Spanish and Americans filling the higher positions. The labor, skilled and unskilled, was paid at about one-third the rates at present prevailing in the United States, the common laborer receiving about fifty cents per day in the U. S. Currency equivalent. The lower rate of wages paid should be remembered in considering the cost of work later for comparative purposes. It was considered desirable to utilize the French working organization as the nucleus, to be enlarged and expanded as the work progressed. Cost of, and time required for the completion of the Summit excavation at Culebra is the controlling factor of the problem, while the amount of material required to be removed will very from 50,000,000 to 250,000,000 cubic yards, more or less, according to both general

and detail plans hereafter to be adopted. At least about 50,000,000 cubic yards will require removal even to provide a canal on the ninety foot above the sea level plan. It will therefore be apparent that, subject to certain conditions, the construction work could be carried forward pending the consideration of the final plan. Again, as time and cost are largely controlling elements which should be known in the consideration of all plans, it is evident that the data attained from actual work would form a valuable basis for such consideration. The work was therefore carried forward with this end in view.

During the year ending June 30, 1905, the technical studies, surveys and construction work have been organized and carried forward as indicated. A general engineering and construction organization has been built up to control, supervise, and carry on the work. The general administration of the work was under the direction of the Chief Engineer assisted by the officers under him. The routine work was supervised by a series of bureaus, the heads of which reported to, and received their instructions from, the Chief Engineer.

BUREAU OF SUPPLIES.

This bureau has the control, custody and issue of all supplies, materials and machinery in store, supervising requisitions and keeping record of the same, and also purchasing such supplies as are needed immediately and can be procured locally.

BUREAU OF PERSONNEL AND QUARTERS.

Controls all matters relating to applications for employment on the Isthmus, *i. e.*, records of employees, supervision of time-keeping; housing and quartering of employees; providing transportation and, in fact, exercising general control and care over all employees as to their records of service, personal comfort and necessities.

BUREAU OF BUILDING AND ARCHITECTURE.

Planning, desigining and constructing all new buildings; supervising the repairs and maintaining buildings in use, this including 2,400 buildings, storehouses, dwellings and other buildings constructed by the French Co.

BUREAU OF MACHINERY.

Contracting the design of new shops and machinery, the construction and repair of the same, thus filling the same functions as a machinery department in an American railway system.

BUREAU OF MAPS, PRINTING AND LITHOGRAPHING.

All work of the above character needed on the Isthmus is performed by this bureau.

BUREAU OF CLIMATIC CONDITIONS AND RIVER HYDRAULICS.

Engaged in the collection and compilation of data on these and all related subjects.

BUREAU OF COMMUNICATION.

Planning, constructing and maintaining telephone and telegraph lines and all methods of communication. The construction work is divided tentatively into five divisions under the control of division engineers to be selected as the necessities of the work demand it, who should have control of all construction and engineering work inside the limits of their respective territorial boundaries. Under the division engineers resident engineers supervise separate or special work; technical or construction. Under the resident engineers assistant engineers are employed with the usual organization of instrument men, rod-men and chain men. The details of the divisional and bureau organizations will furnish material for a separate article, and are only touched upon at this time in order to give the reader a general idea of the conduct of the work.

In selecting the Advisory Board of Engineers to consider the general plans proposed for the Panama Canal, no engineer from Mars, that planet of canals, was included.

An engineer from Mars in considering this problem from a disinterested standpoint unaffected by any motive except to obtain full information of the basic facts and arrive at a correct conclusion would want to know.

1. Why build an Isthmian Canal?

A. General reasons affecting civilization

B. Special reasons affecting United States.

C. Political policy questions to be considered.

D. Commercial policy and reasons as to its necessity.

C. Patriotic reasons therefor.

2. If the construction of an Isthmian Canal is necessary or advisable, have all other routes been fully and properly considered and has it been fully determined that the Panama is the most practicable and best, and why?

3. As the function of a canal is simply the transportation of persons and material across a given space in the shortest time and at a minimum expense, what consideration has been given to this face of the question comparing a canal with other facilities for accomplishing the same result?

4. In case facts and conclusions show Panama to be the best route and a canal to be the most practicable service for accomplishing the

purpose, what information is at our command to determine the following points in considering the selective merits of different plans?

A. Utility.
B. Cost of construction.
C. Time required for completion.
D. Cost of maintenance.
E. Cost of operation.
F. Time of transit.

While comparative advantages and difficulties should, if possible, be measured by financial and commercial considerations, questions of general policy should be considered and the element of human judgment cannot be entirely eliminated.

5. Following the selection of a general plan, important details would be taken up and after full consideration, decided upon.

A. Harbor approaches and works including docks, wharfs, anchorage basins and incidental facilities.
B. Cross section of canal, treatment of slopes and other matters.
C. Location and character of locks, dams, spillways.
D. Division channels, care of flood waters from adjacent drainage slopes.
E. Control of Chagres and other rivers and principal works pertaining thereto.
F. Water and sewerage for cities, towns and working settlements.
G. General sanitation and care for treatment of ill and injured employees, hospitals, etc.
H. Provisions for working force, quarters, commissary, amusements, etc.
I. Government of town.

In the execution of the work, however, the last should be considered first.

6. Plans having been determined upon, questions of control, administration, and execution should be considered.

A. Can the work be carried on to the best advantage using the present Governmental Department and Bureau, their methods and machinery?
B. Or should the work be considered of an emergency nature and suitable special provision be made for its proper management as may be required by the unusual conditions existing in connection with it.

7. As to the conduct of the work.

A. Should it be turned over to a general contractor or syndicate.

B. Divided into as many small separate contracts as possible under governmental control.

C. Carried on under immediate governmental direction by hired labor.

D. Or a combination of the last two methods.

What are the advantages for or against these several suggestions?

While the visitor from Mars might be told to confine himself to the question of which of the several plans suggested for the Panama Canal was the best, he would doubtless reply that having come so great a distance and coming from a planet of canal builders he would at least suggest the advisability of the earth's inhabitants permitting him to go into the subject "de novo"—and receiving the full benefit of his experience and knowledge. It certainly would do no harm as the wisdom of the American Congress would be required to formulate the laws needed to make his suggestions effective.

However, the gentleman from Mars would doubtless desire much other information, both general and detail, before passing on the wisdom of the policy to be adopted in planning and executing this important work, having no political ambition (miscalled patriotism), no supplies or machinery to sell, no friends or relatives to provide for, no axe to grind. Never having heard of the modern expression "graft" and having no personal selfish ends to serve, he would naturally desire to know and carefully weigh all facts and form a conclusion that would not only be of the most benefit to mankind, but would also meet the approval of his fellow canal experts upon his return to his native planet.

The highest patriotism will certainly be conserved by considering the question along the lines mentioned above as far as possible. And such will be our effort.

The difficulties met with in building up an organization of 7,500 men consisting of the variety of qualifications needed for the work in a tropical country two-thousand miles from the seat of government, subject to the peculiar conditions surrounding and controlling the Panama Canal cannot be described in a short introductory article. If this and succeeding articles written by the writer or others may assist the reader to a more complete understanding of the Panama problem, the object of the writer will have been accomplished.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester.

In introducing Mr. Koester's first article, which appeared in the issue of this magazine for August, we drew attention to the interest and value given to his discussion by the comparisons he makes between Continental, British, and American practice, and the practical information he supplies regarding some of the most important work of the best modern designers. In the following article he takes up coal-handling machinery and the steam-generating plant. A succeeding part of the discussion will take up steam-piping, prime movers, and the condensing plant and auxiliaries.—THE EDITORS.

II. COAL AND ASH HANDLING.

IN modern power plants, the coal and ash handling are carried on either by electrical or mechanical methods, or both. Whether the coal is transported to the plant by water or by rail, it is lifted and hoisted by means of automatic grab buckets, or dumped from the cars directly into the bunkers. In both cases the coal may be crushed if necessary, weighed, and then by means of belt or bucket conveyors, carried to the storage room at the side of the boiler room, or to bunkers above the boilers, usually occupying the space directly beneath the roof. Here the coal may be stored in different bunkers or bins, according to its calorific value, by means of distribution trippers or other devices. Other systems are those employed at the Vienna and Hamburg plants. In the former case the loaded car, with a capacity of 15 or 20 tons, is raised to a track above the bins by means of an electric motor and then dumped into the ten compartments, with a total capacity of 4,000 tons, sufficient for about six weeks normal operation. About the same amount of coal is stored in the "Barmbeck" plant in Hamburg, where the coal is hoisted from barges in hanging buckets by means of a traveling crane and then placed on one of the six closed-loop tracks shown in Figure 20, where the buckets travel by gravity, being automatically dumped at the proper point, and then return to the starting point and are again lowered to the barge. The cut represents the plant as at first installed in 1900. This comparatively large storage capacity is necessitated on the continent of Europe on account of the frequency of strikes, which however are usually of short duration.

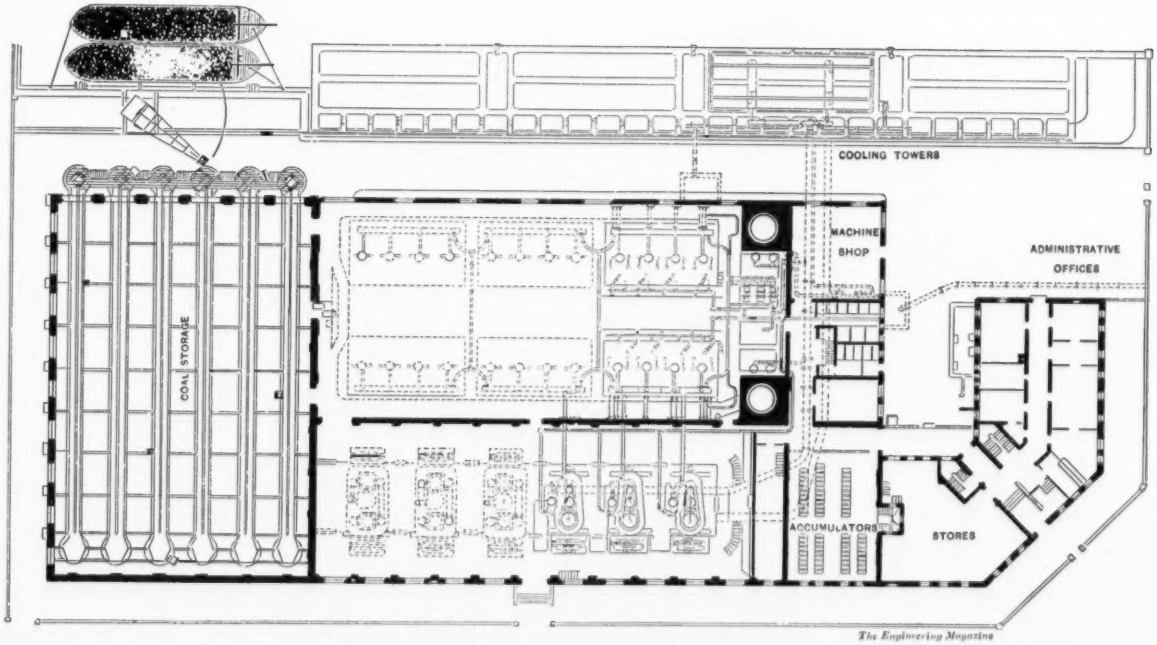


FIG. 20. PLAN OF THE BARMBECK PLANT, HAMBURG.

The evaporation of water with a given heating surface varies with the calorific value of the coal. A coal rich in carbon naturally produces a greater evaporation than a poor one, and as the theoretical heat units per pound of coal varies say from 9,000 to 16,000 British thermal units, it would be unfair to demand from a stoker, either mechanical or human, the same steam production with both qualities of coal. It is of the greatest importance for the economical management of the plant to keep accurate and complete records of the calorific value of the coal fired by each individual stoker. Tests may be obtained by chemical analysis, by combustion in a coal calorimeter, or by actual test in a steam boiler; the results of the latter, however, are extremely variable.

FIG. 21. BOILER INSTALLATION IN THE BILLE PLANT, HAMBURG.

Coal on the continent of Europe is comparatively expensive, hence one will not be surprised frequently to see small cars, after being carefully weighed, hauled before the furnace and coal fired directly from them (see Figures 21 and 22). In the Vienna twin plants, 1.32 pounds per indicated-horse-power hour were consumed, the coal being hand-fired, showing under test 11,940 British thermal units per pound, which means that one indicated horse power was produced by 15,750 British thermal units. The efficiency of the boiler is 72 per cent. These were test figures, and not the average of regular performance.

It will be seen that such favorable results are obtainable only by the employment of skilled stokers and scientific management. Complete tests on the coal and ashes are invaluable to the management.

In connection with their central-station service the New York Edison Co. have recently installed a large coal-storage plant to be used for their various power plants in New York in case of emergency. Owing to the lack of available space at the different stations, this plant has been located on the East River opposite 110th Street in Shadyside; the capacity of this storage plant will be 150,000 tons, two-thirds of which will be for anthracite while the remainder will be for bitumi-

FIG. 22. BOILER PLANT OF THE MUNICIPAL POWER STATION, VIENNA.

nous coal. The entire coal-handling apparatus is being installed by the Dodge Coal Storage Company, and a splendid view is given in the accompanying illustration Figure 23. One of the coal-handling plants connected with their power stations is shown in Fig. 41. In the Moabit plant of Berlin the River Spree was deflected in order to secure a sufficient coal-storage capacity.

III. BOILERS.

The judges at the Centennial Exposition in 1876 adopted a standard boiler horse power, which is the evaporation of 30 pounds of water from a temperature of 100 degrees F. to dry saturated steam at

70-pounds pressure, this being subsequently incorporated in the standard code of the American Society of Mechanical Engineers. The expression is still in general use in conjunction with the heating surface. The expression of boiler horse power is unknown on the continent of Europe. At the present time, when prime movers are operating under a pressure of 175 to 200 pounds and more, and feed water is generally calculated at about 200 degrees F, it will be seen that the above expression cannot be of great value. In order to determine the size of steam boiler proportioned for the prime mover, one must consider the design of the boiler, the proportion of grate surface to heating surface, the character of the fuel, and the draft of chimney, or forced or induced draft if such be employed. With a well designed and properly set boiler, the temperature of the waste gases should not exceed that required for a sufficient draft; therefore in an up-to-date plant, to the above mentioned items must also be added

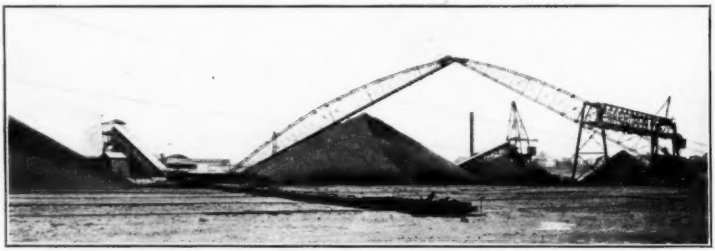


FIG. 23. DODGE COAL STORAGE SYSTEM.
Installed for N. Y. Edison Co. at Shady Side, N. J., by the Dodge Storage Company, N. Y.

the economiser, and—most important of modern power-plant equipments—the superheater.

Today, with the installation of a high grade of engines and turbines, and the necessary ability to start the individual units at short notice (on account of the sudden fluctuations in load, especially noticeable in railway work) it is necessary to install boilers of equal efficiency. Good power-plant design demands the production of a horse power with the smallest amount of space, without undue crowding in either the engine or the boiler rooms, an example of this already having been shown of 7.5 sq. ft. heating surface per square foot boiler room floor space as against 4.0 in two of the plants recently constructed in New York and Paris respectively.

With the adoption of gauge pressures ranging from 175 to 200 pounds, and even higher, as standard practice in modern plants, the water-tube boiler is without question the safest and most favorable

type of steam generator. This has resulted in the production of a great many different types of this kind of boiler, especially on the Continent of Europe, descriptions of which are here impossible. Suffice it to say that the power-plant designer must take into consideration all points which would lead to an efficient and economical operation of the plant, of which the above mentioned items are the most important.

The boilers of the Sheffield plant England, are of the Stirling five-drum water-tube type, manufactured by the English Company. Each boiler has a heating surface of 6,210 square feet, and is provided with four furnaces and a grate surface of 72 Stirling superheater square feet, and a raising the temperature of steam under a pressure of 200 pounds to about 475 degrees F. Each boiler has its own induced-draft system, operated by electric motors, the air supply to the furnace being heated up to 315 degrees F. by the flue gases. Tests reported by Felden in "Engineering" give an evaporation from and at 212 degrees F. or 10.4 pounds of water per pound of coal, the latter having a calorific value of 11,886 British Thermal units. The boiler pressure was 196.8 pounds and the total average temperature of the steam 475.4 degrees F. The efficiency reported to have been obtained, including superheat, is 84.9 per cent. while the guarantee

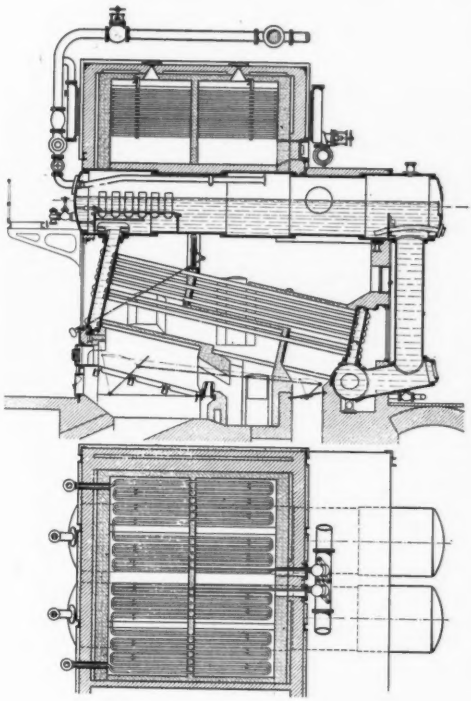


FIG. 24. LEINHAAS BOILER WITH HERING SUPERHEATER.

at the most economical load was that it should be not less than 80 per cent.

As it was until recently unusual to have marine tube boilers in a central station, and as two of the recent plants, viz. Carville plant in

FIG. 25. GROUP OF 8 512 H. P. BABCOCK & WILCOX BOILERS, SUPPLYING STEAM TO ONE 5,000 K. W. CURTIS TURBINE. Installed by The Babcock & Wilcox Co., New York, in power house of The Edison Elec. Ill. Co., Boston, Mass., U. S. A.

Newcastle and the St. Denis, Paris, are respectively equipped and being equipped with this type of steam generator, it may be of interest to give here a few details. The boiler of the St. Denis plant is of the

Babcock and Wilcox make, and has a heating surface of 4,494 square feet and covers a floor space of 267.5 square feet. Each boiler has two chain grates of 35 square feet each, and a superheater, of 642 square feet heating surface, made up of seamless drawn bends with arrangement for flooding. The specification calls for a steam temperature of more than 680 degrees F. at a pressure of 175 pounds. The boiler itself consists of a drum about 17 feet long and 52¾ inches in

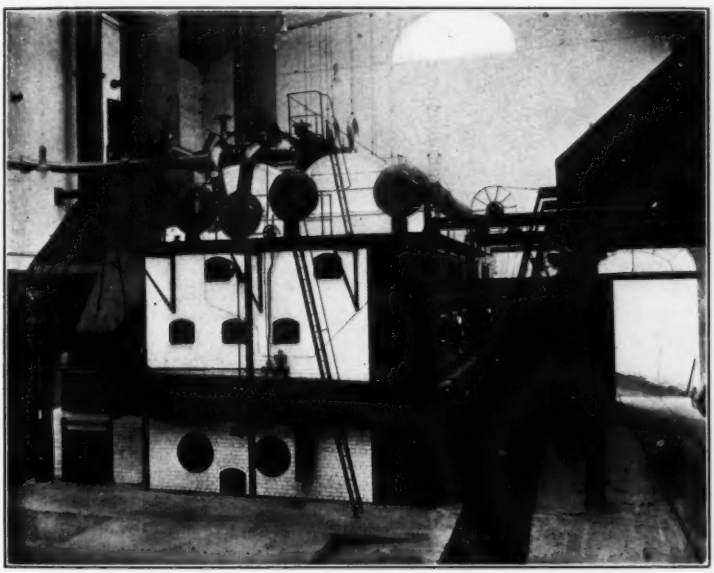


FIG. 26. STIRLING BOILERS AT SHEFFIELD (ENGLAND) ELECTRIC LIGHT STATION.

diameter, which lies across the front of the boiler setting, 16.1 feet above the floor level. There are 33 sections of 14 rows water tubes of 3¼ inches diameter, 10.1 feet long, sloped at a large angle. The superheater is located above these tubes. Directly above this boiler unit, 23 feet above the boiler-room floor and close under the roof, is a tier of Green economisers. The whole—boilers and economisers—are supported by steel construction, in a very compact way in order to reduce the loss of heat to a minimum. Between the economisers and the middle of the boiler house is a steel constructed coal bunker, from which the coal dumps into the stoker hoppers. The ashes are collected in the basement floor (9.8 feet below the boiler floor) and carried away by the same bucket conveyor which takes the coal to the

bunkers. From the basement floor to the top of the boiler house is about 65 feet only. It will therefore be seen that not only the boiler itself is compact, but the entire boiler plant, which may also be said of the turbine house. Compared to this it may be noted that the New York Subway plant, having also one basement floor, one boiler floor, one economiser floor, as well as a coal bunker, has a height from basement floor to the top of the boiler house of 125 feet.

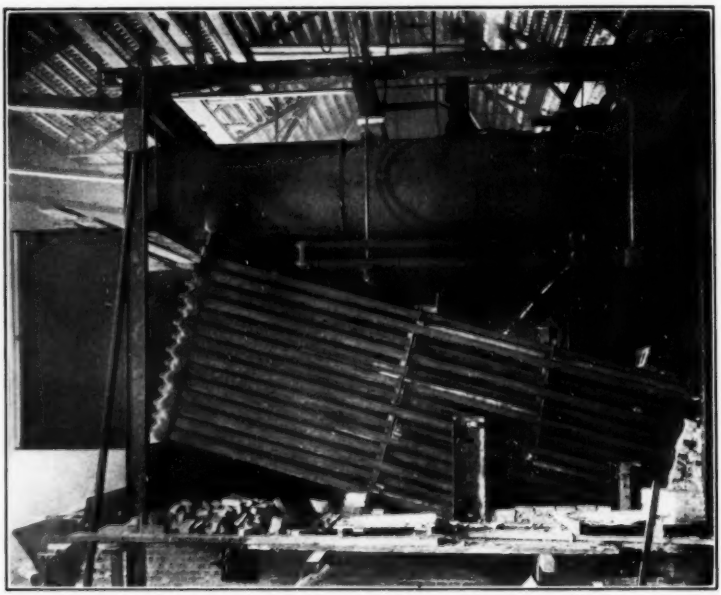


FIG. 27. PART OF THE BOILER PLANT, FULLERTON AVENUE POWER STATION, CHICAGO MUNICIPAL LIGHTING PLANT.

Foster superheaters and water-tube boilers; units 520 h. p. each; 165-lb. pressure and 125 degrees superheat. Power Specialty Co., N. Y.

To the convenience of the boiler attendance often too little attention is paid. Galleries in the front of the boilers above the fire doors and a platform on the boiler itself greatly facilitate the operation. The constructor of the New York Subway plant, after visiting continental plants, has successfully used this system.

IV. STOKERS, SMOKE CONSUMER, AND DRAUGHT.

Mechanical underfeed and overfeed stokers are much more commonly used in the United States than elsewhere. This may be due to the high wages required for skilled stokers and the low price of coal, in

America. It is certain that with a mechanical-stoker equipment, regardless of type, a boiler cannot be forced as rapidly or as high as by skilled hand firing. Another serious disadvantage of mechanical stokers is that they are limited to certain grades of coal, which may also prove disastrous in case of strike. The dropping through of fine coal, either by step or chain stokers, gave rise to the design of special coal receivers built into the floor beneath the stokers. It cannot be denied that mechanical stokers have their advantages and good features, one of which, of especial value where superheaters are built

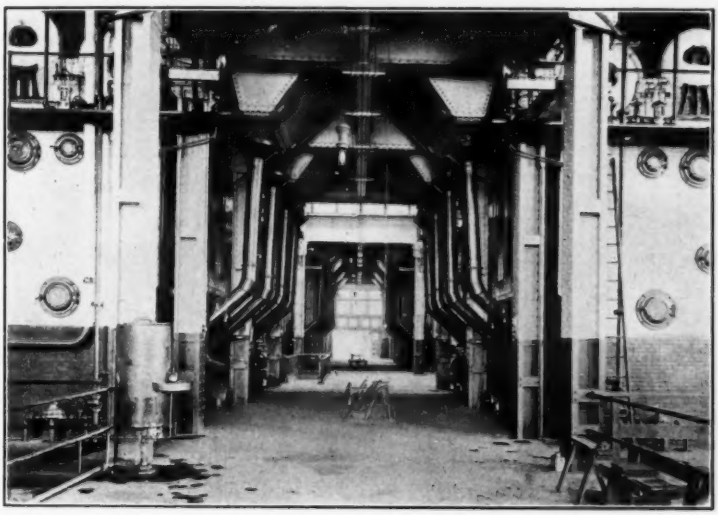


FIG. 28. NEW POWER STATION OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

The plant now comprises 18 water-tube boilers of 500 h. p. each served by 36 American Mechanical Underfeed Stokers. Four more boilers, with 8 stoker equipments, are being installed, raising the total to 11,000 h. p. The American Stoker Co.

into the boiler settings, is the avoidance of cold drafts due to the opening of the fire doors.

It is often claimed that with the installation of stokers the smoke consumption is increased; this may be equally true with hand firing when in both cases a coking arch is installed. It is true that the more surplus cold air enters the furnace, the less complete is the smoke combustion. If the air entering the furnace chamber is previously heated, the combustion will be proportionately augmented. There are two different methods of supplying this air, either directly

from the ash pit, usually not of high temperature, or through ducts in the boiler setting around the fire chamber. A good illustration of the first mentioned method will be seen in Figure 24, which represents a Leinhaas boiler equipped with Hering superheaters and Dubiau artificial water circulator and the above described smoke consuming device. As will be noticed the entire combustion chamber is covered, and at the end of the grates air is introduced and thoroughly mixed with the passing furnace gases, the heat produced at this point, on account of the smoke consumption, being so enormous that the tubes

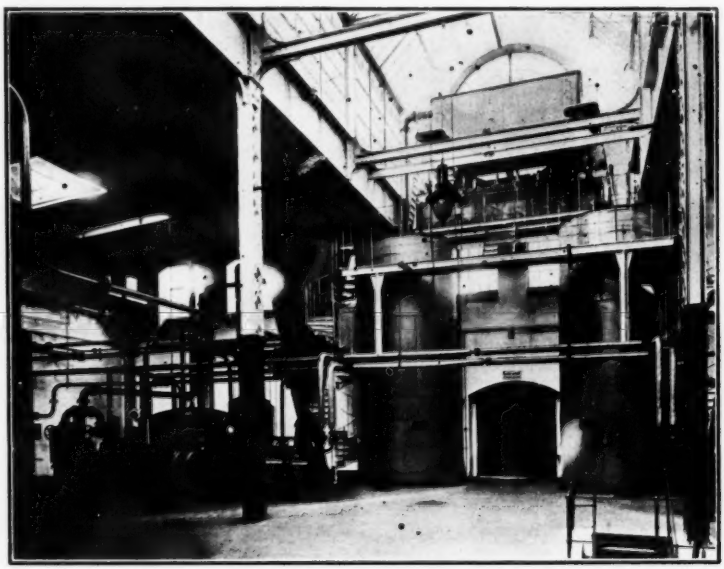


FIG. 29. DERVAUX-REISERT WATER PURIFIER, EACH OF 1,400-CU. FT. PER HOUR CAPACITY.

would be rapidly burned out did not the heavy reinforcement of the coking arch protect them. I feel confident that the combustion in this case would be incomplete if the air were drawn directly from the ash pit; but if, as previously suggested, the air is heated in ducts in the boiler setting or from the flue gases, a complete combustion would undoubtedly result. The decrease in the coal consumption is greater than generally imagined, and may be even 20 per cent, besides allowing a satisfactory use of the poorer grades of coal. By the introduction of steam into the furnace chamber, often used for smoke combustion, it must be borne in mind that the cost of operation is in-

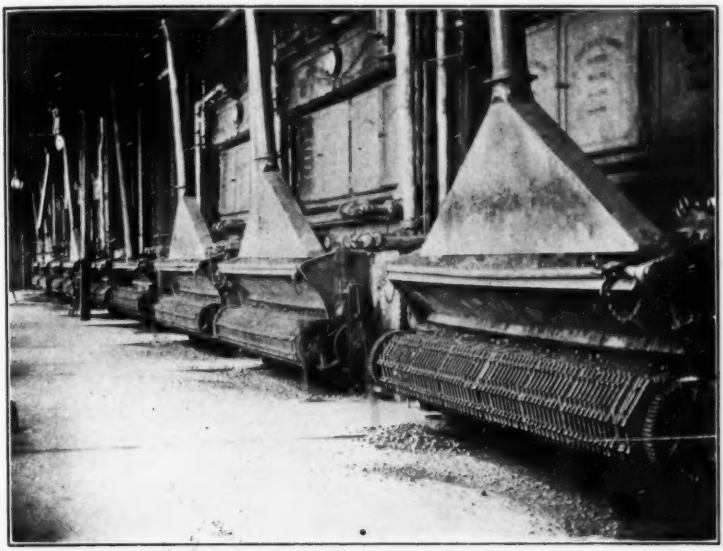


FIG. 30. BOILER PLANT, EAST ST. LOUIS & SUBURBAN POWER HOUSE, EAST ST. LOUIS, ILL.

Ten 575 h. p. Heine boilers arranged in 5 batteries, and equipped with Green traveling chain grates. Coal is fed from overhead bunkers, filled by conveyors direct from cars. Ashes are handled by conveyors beneath, discharging directly into empty cars. Heine Safety Boiler Co., St. Louis.

FIG. 31. BOILER-ROOM INTERIOR, PHILADELPHIA & READING R. R., READING, PA.

Eight 250 h. p. Wickes vertical water-tube boilers. Six more now being added. Wickes Bros., Saginaw, Mich.

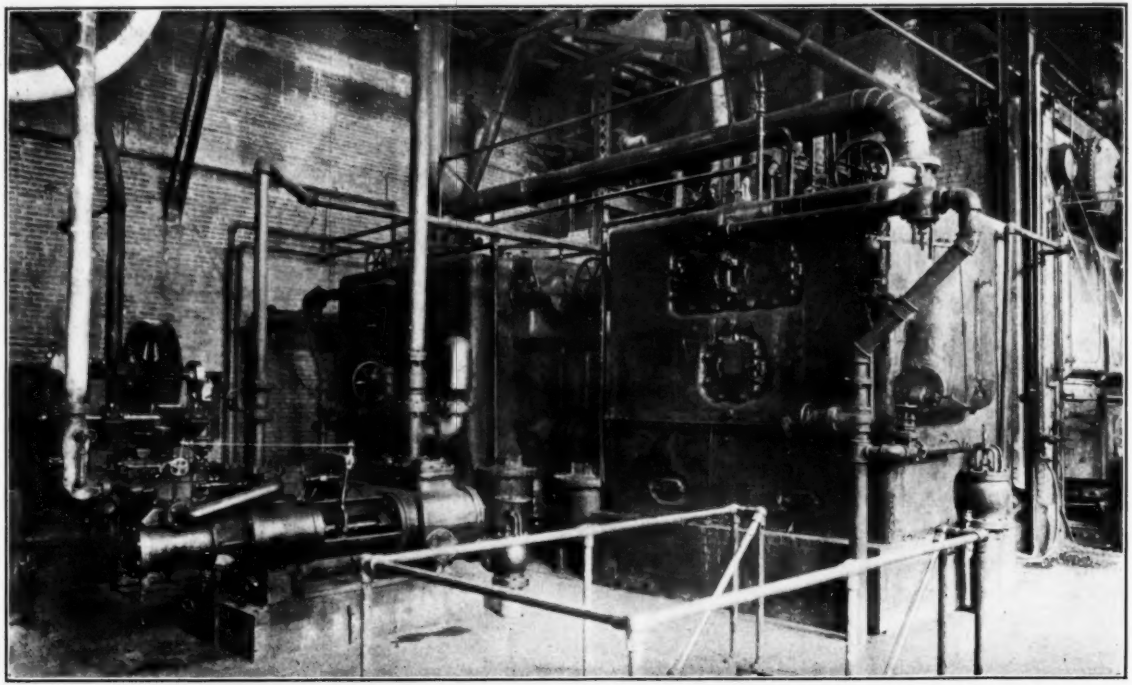


FIG. 32. SORGE-COCHRANE FEED-WATER HEATERS. POWER PLANT LOUISVILLE STREET RAILWAY COMPANY, LOUISVILLE, KY.
For heating and purifying water for 3000 h. p. of boilers. Harrison Safety Boiler Works, Philadelphia, U. S. A.

creased. This may also be said where steam is used to aid the natural draught in the chimney.

Mechanical, forced, or induced draughts also are found more frequently used in the United States than in any other country. This may also be due to the higher wages demanded by skilled stokers. Mechanical draught should replace the natural draught obtained with a high chimney. The former is comparatively more often found in connection with hand firing than with mechanical stoking, as a poor fireman needs the assistance of the blower. It may also be stated that with certain types of mechanical stokers, an uneven combustion may result from the use of mechanical draught. Of course, mechanical draught properly supplied has many advantages in certain respects.

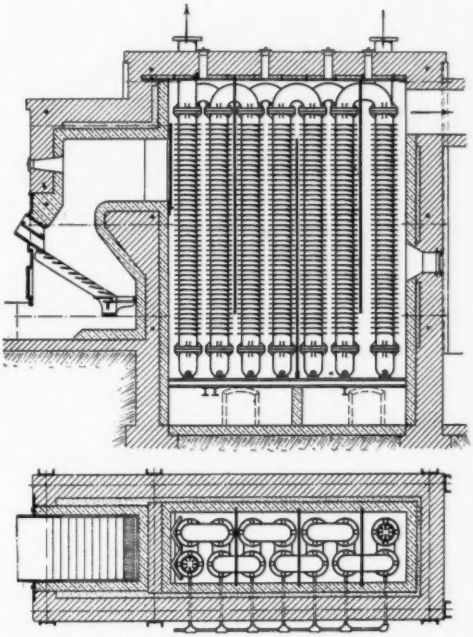


FIG. 33. SEPARATELY FIRED SCHWOERER SUPERHEATER.

V. BOILER FEED WATER.

As nearly all natural waters contain more or less impurities, it is of the greatest importance to purify the feed water before it enters the boiler. The foreign substances of most frequent occurrence are calcium sulphate and carbonate, magnesium carbonate, magnesium chloride, etc., all of which are the cause of more or less deposition of scale in the boiler, which is soon noticeable by reduced evaporation. The presence of this scale in boiler tubes increases the liability of burning out. The formation of scum and collection of mud in the boiler are also undesirable results of impurities, but although the bad effects of the latter may be easily overcome by frequent blowing off, this materially decreases the efficiency of the plant.

The first cost of a water-purifying system is not of great importance, and the larger the plant the cheaper comparatively it is. The cost of maintenance is also low, as the price of the chemicals generally used is small and it does not require close attention. All other work, such as the proportionate supplying of chemicals, is secured automatically and their thorough mixture is accomplished mechanically. It will be seen that an installation of this apparatus in an up-to-date plant will be of great benefit, and on account of the saving effected will soon repay the cost of installation. The accompanying illustration, Figure 29, shows an equipment of two feed-water purifiers with a capacity of 1,400 cubic feet per hour each.

Not only will the purification of the boiler feed water assure an increased efficiency, but the benefit of raising the temperature previously to entering the boiler to a degree near the boiling point is to-day well recognized. This may be done by exhaust or live steam, or the waste boiler flue gases. By the utilization

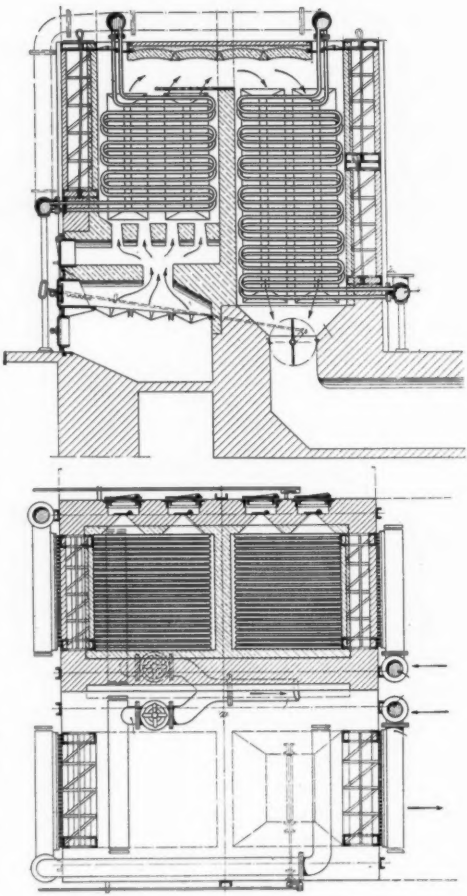


FIG. 34. SEPARATELY FIRED SUPERHEATER ON THE SYSTEM OF THE ASCHERSLEBENER MASCHINENBAU AKTIEN GESELLSCHAFT.

of exhaust steam with closed or open feed-water heaters, a temperature of some 190 degrees F. may be reached. When the feed water is heated by means of live steam, it must be borne in mind that the heat thus supplied to the water and returned to the boiler increases the life of the boiler, and the increased efficiency must not be underrated, provided the water is fed to the boiler in a short time, before the heat is dissipated. The only loss is that due to radiation in the steam pipes and the water tanks.

As the latest practice of prominent European engineers is the adoption of electric-driven auxiliaries for the condensing installation, only the exhaust from the feed pumps remains available for feed-water heating; and as this, in well designed plants, should not exceed ½ of 1 per cent; it will be seen that this is not sufficient to raise the temperature of the water to some 200 degrees F. The condensed steam itself at a high temperature may also be used as feed water provided it contains no oil. This practice may be followed also where a jet condenser is used, provided the circulating water is suitable for boiler purposes.

Where the escaping flue gases are at a temperature higher than is required for a good draught, the installation of economizers will be the best system for heating boiler feed water. Although the economizer, whether enclosed in brick setting or iron casing, requires a large floor space, its advantage in modern plants is well recognized. And when mechanical induced or forced draught is employed, one may take advantage of almost the entire heat in such a way that the discharging temperature is practically no higher than that of the atmosphere. Experience has proven that with a good and well set economizer, 240 degrees to 250 degrees F. and higher may be reached, and that the greater the waste of heat in the boiler itself, the greater the benefit of the economizer. From 10 to 15 per cent may be saved in the coal consumption, and to assure a still greater efficiency, the exhaust of the boiler feed pump (which is usually a good steam consumer) must be sent through coils into the cold-water storage tank, the pump being placed between tank and economizer. All pipe runs should be as short as possible, especially between the economizer and boiler, in order to reduce the condensation to a minimum. Pipes of this character in American practice are usually well covered in order to prevent the loss of heat, and frequently these pipes are made of brass. In Europe the old practice of making these pipes of highly polished copper is still found today, which method is claimed to be more efficient than the use of the best obtainable covering. This sys-

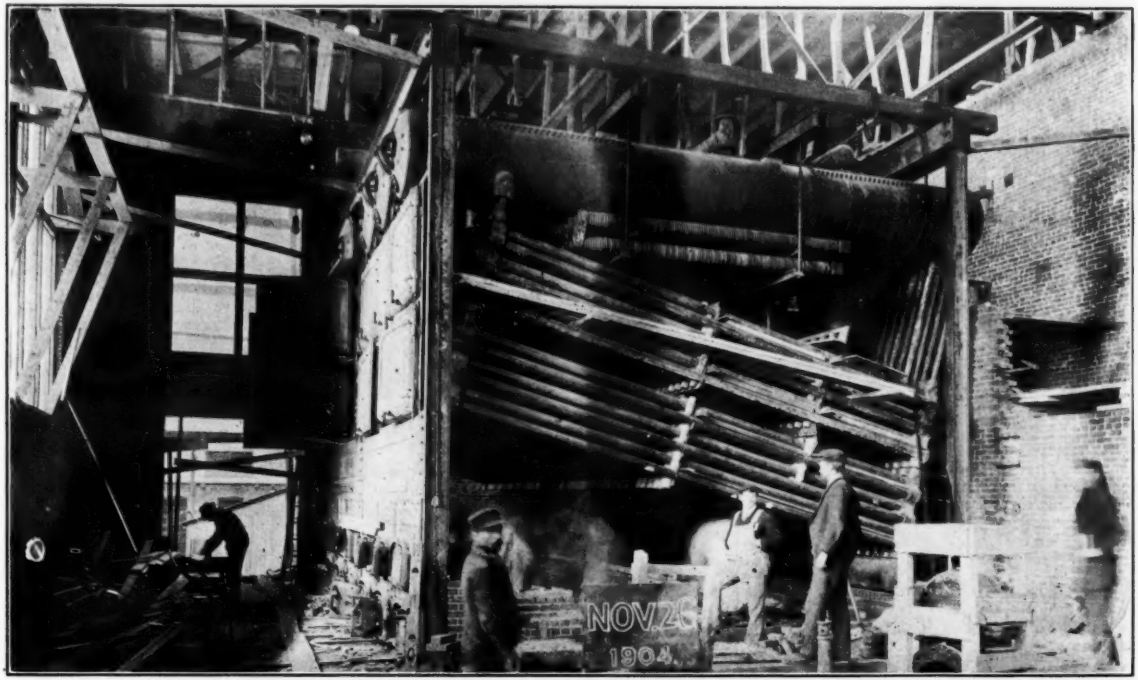


FIG. 35. FOSTER SUPERHEATERS. WATER TUBE BOILERS. SIX UNITS; 600 H. P. EACH; 165 LBS. STEAM; 100° SUPERHEAT. POWER SPECIALTY CO., 111 BROADWAY, N. Y.

At Hartford, Conn., Electric Light Station. A modern plant erected by The Westinghouse Kerr Co. and conspicuous for having used the first 1500 k. w. Westinghouse-Parsons turbine.

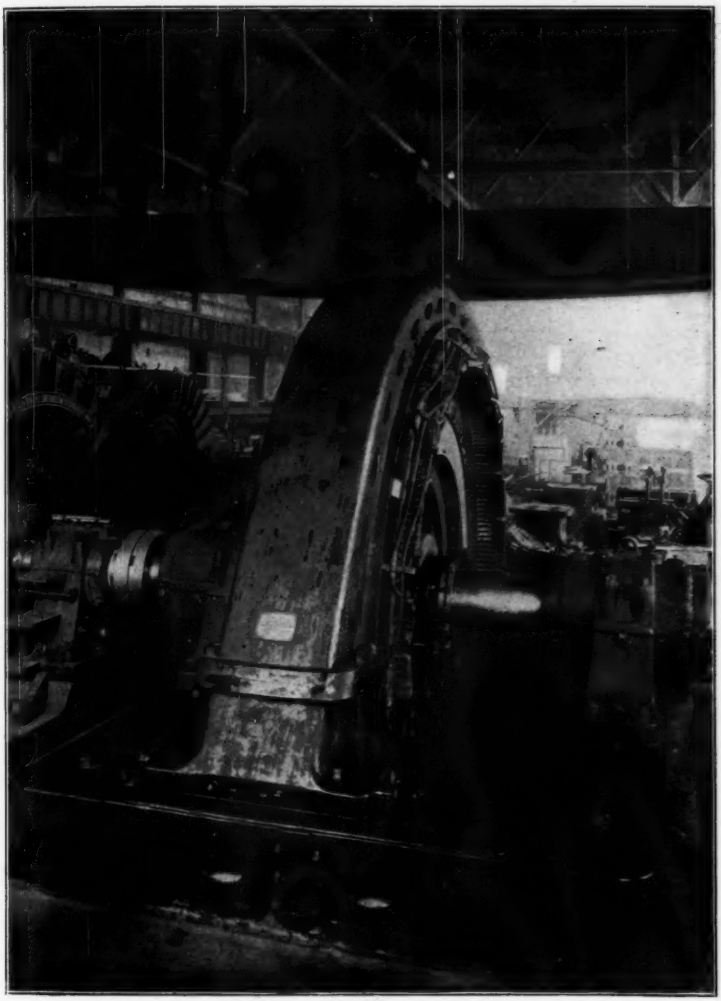


FIG. 36. 10,000 H. P. A. C. GENERATOR.

Driven by water wheel; power house of the Ontario Power Company. Installed by Westinghouse Electric & Mfg. Company, Pittsburg, Pa., U. S. A.

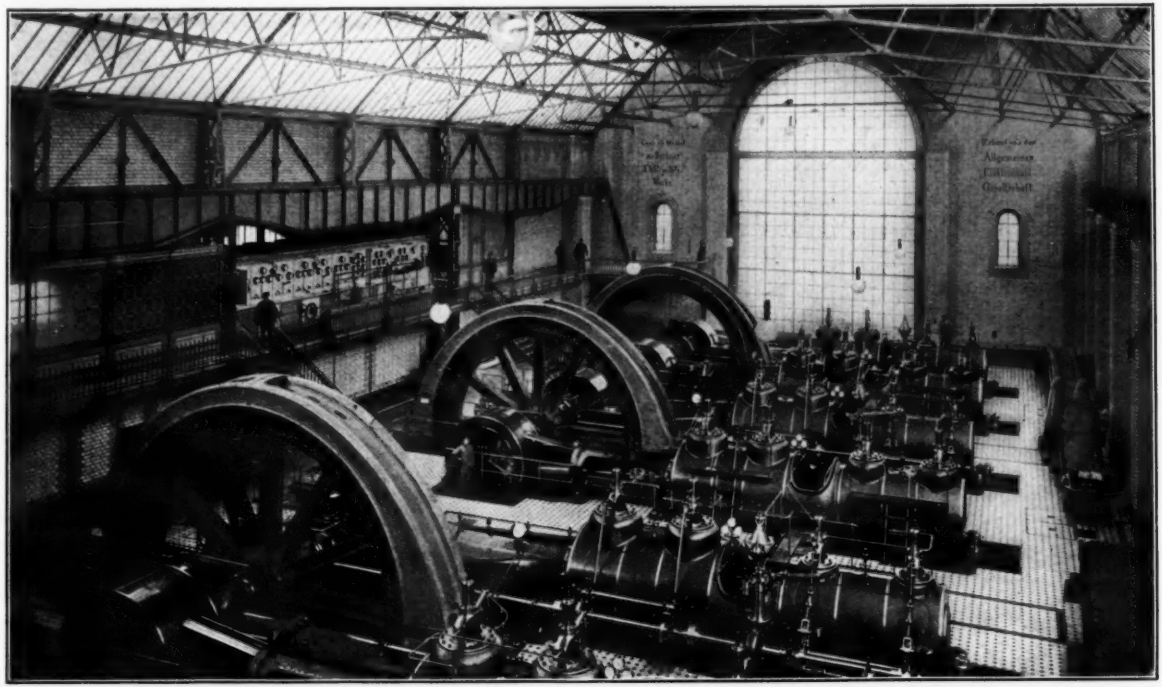


FIG. 37. THE MOABIT ELECTRIC-POWER STATION, BERLIN.

Containing four Sulzer Engines and Allgemeine Electricitats Gesellschaft Dynamos, the engines being of 3,000 horse-power each and fitted with triple-seated lift valves, and Sulzer valve gear. Installed by Gebruder Sulzer, Winterthur, Switzerland.

tem would still be in common use were it not for the introduction of superheated steam, which on account of its high temperature precludes the use of copper.

VI. SUPERHEATED STEAM.

Undoubtedly the most important feature in up-to-date boiler-house equipment is the utilization of superheated steam, the benefits of which are directly noticeable at the coal pile and water tank. It is well-known that the theoretical efficiency of an engine depends on

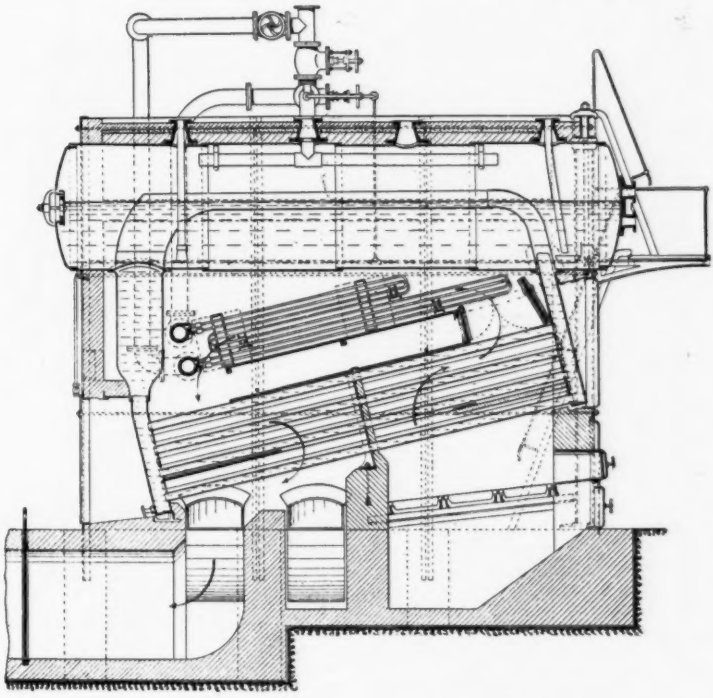


FIG. 38. BÜTTNER BOILER WITH SUPERHEATER.

the difference in temperature between the supply T_1, and the exhaust T_2, and since (as has often been proven on the continent of Europe) for each 9 degrees F. of superheat introduced to the engine the steam consumption may be reduced 1 per cent, it will be easily seen that the greater T_1 the higher the efficiency of the engine, provided it with-

stands the heat. Another, though less important, advantage in the use of superheated steam, is the reducing of condensation in the mains.

The additional heat necessary to produce a given temperature of superheat depends entirely upon the design of the apparatus, and whether it is separately fired, or how located in the boiler setting. In order to determine the exact amount of heating surface required to

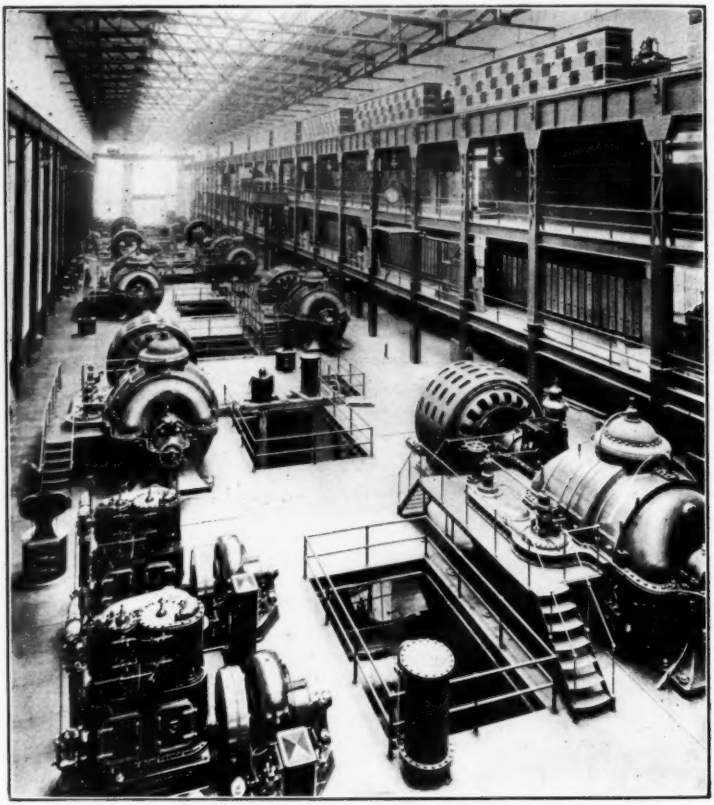


FIG. 39. CHELSEA POWER STATION, CHELSEA, ENGLAND. INTERIOR.

produce a given degree of superheat, it is necessary to test each particular design of superheater under conditions similar to actual practice. The ratio of superheater to boiler heating surface required to produce a given temperature depends further on the amount of steam furnished per hour, on the steam pressure, and on the quality of fuel used.

The enormous benefit of superheat may be shown in the following example:—Assuming an engine running with dry saturated steam and using 14 pounds per horse-power-hour; by the use of 135 degrees F. of superheat, according to the law already stated, the steam consumption would be reduced 15 per cent, to 11.9 pounds. Now, assuming the evaporation of 8 pounds of water per pound of coal, we need—instead of 1.75 pounds as in the former case—only 1.48 pounds in order to produce the required amount of dry saturated steam. With no surplus heat in the flue gases, we require in addition to this approximately 10 per cent (higher than average) of 1.48 pounds, making a total of 1.62 pounds, to raise the temperature of this steam to 135 degrees superheat, showing a saving of 7.4 per cent in coal consumption.

To give the financial aspects of a similar problem making the same assumptions as above:—Assuming a 5,000-kilowatt unit to run 24 hours a day and 360 days in a year the water consumption would be 2,960,000 cubic feet, which by the use of the above superheat would be reduced by 15 per cent, or 1,944,000 cubic feet, and as the price per 1,000 cubic feet is $1.00 there would be a saving of $1,944. For the same unit the annual coal consumption would be 50,652 tons, the use of superheat effecting a saving of 7.4 per cent or 3,748 tons, which at $2.50 per ton would amount to $9,370. This makes a total annual saving of $11,314, due to the use of superheated steam. As we have today plants of ten such units, the handsome saving of $113,140 would be effected annually by the use of superheated steam. Assuming sixty boilers to be necessary for the operation of this plant, and one superheater at a cost of $2,000 (a fair price) to be installed in each boiler, it will be seen that the total additional cost of $120,000 would be almost repaid in the first year leaving thereafter an ample saving, after making all allowance for depreciation, interest, etc.

The importance of the superheater is not generally recognized in the United States, as is evidenced by the fact that prominent plants have recently been constructed from which they have been entirely omitted, or in which only a low degree of superheat has been used. The objections often raised against superheaters are that the engine would not stand the increased temperature, or that their installation would not pay. The latter result might be due to improper choice of relative heating surfaces; the former would be due to poor design on the part of the engine, as this difficulty has been entirely overcome on the continent of Europe, where up to 300 degrees F. of superheat are frequently used both with reciprocating engines and turbines.

A case may arise where an increase in the capacity of a boiler plant is required, yet there is no space for an additional unit. This difficulty may be overcome by the introduction of superheaters. I recollect a plant in Gandersheim, Germany, where there were originally six boil-

FIG. 40. WATER-SOFTENING AND PURIFYING SYSTEM AT GRAND RAPIDS, HOLLAND & CHICAGO RY. CO., JENNISON, MICH.

"We-fu-go" plant of 1,000 h. p. capacity, installed by Wm. B. Scaife & Sons Co., Pittsburg, Pa.

ers and it became necessary, apparently, to add one more. Instead, four Szamatolski superheaters were installed, enabling one boiler to be held in reserve.

There are two types of superheaters—steam-tube, in which the steam passes through tubes surrounded by flue gases, and, flue-gas superheater, in which the flue gases pass through the tubes surrounded by steam. The latter type generally exhibits a flat, box-like construction, in which a number of staggered rows of short tubes are placed. The design is comparatively recent.* These superheaters may be sub-classified as dependently and independently fired, a choice

* Berner Zeitschrift des Vereines Deutscher Ingenieure.

between these latter two depending entirely upon the power plant design.

The large majority of steam-tube superheaters are made up of a number of return bends or tubes of small diameters, of steel or wrought-iron. The intention in this type is to divide the steam into many parts, forcing them at high velocity through the tubes, thus bringing all the steam into close contact with the heating surface. The thinner the walls of the tubes the more rapid the transfer of heat; but as these tubes are also easily affected by cold draughts, more skilful attendance is required than with the heavier construction. There are some types on the market of such heavy construction that it is unnecessary to flood them or shut them off by means of dampers before steam is generated. The regulation of the superheat may be

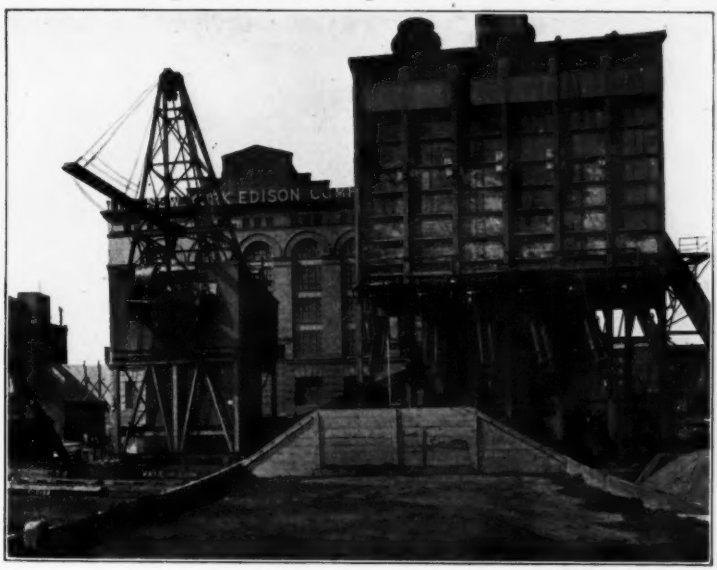


FIG. 41. COAL-HANDLING INSTALLATION, NEW YORK EDISON COMPANY'S WATER-SIDE POWER STATION, EAST RIVER.

Steel unloading tower on wheels; direct-acting hoisting and trolley engines, 14 by 24 and 10 by 12 respectively; coal passes from hopper through single crushing roll driven by 10 by 10 engine; thence is handled by belt conveyors to suspended weighing hoppers, and from there by another conveyor to boilers. Capacity, 3 to 4 tons per minute. The Mead-Morrison Mfg. Co., N. Y.

accomplished by means of dampers (Figure 38) controlling the flue gases, by mixing the superheated steam with dry saturated steam, or by having water tubes concentrically located in the steam tubes of the

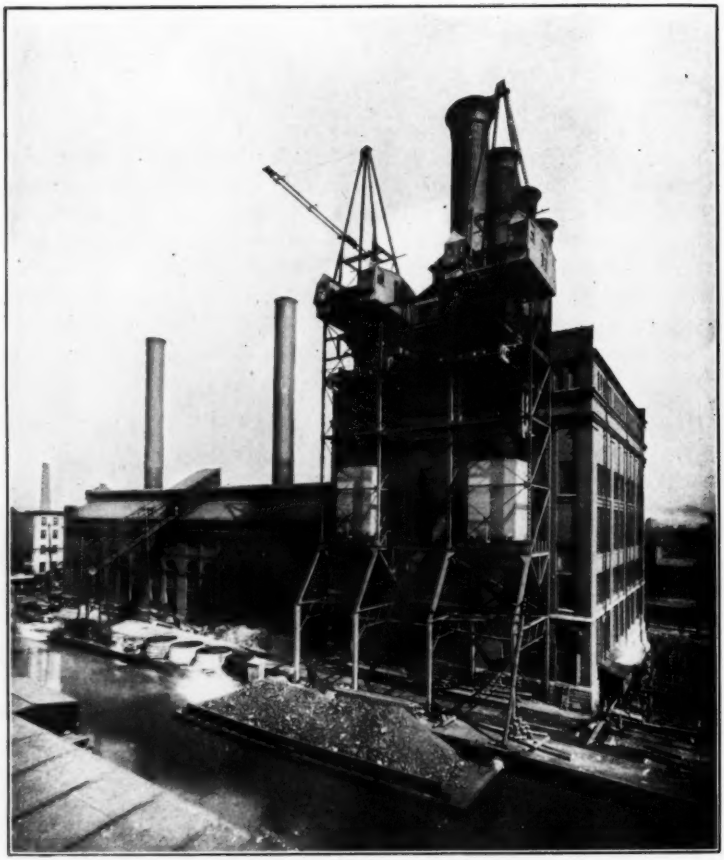


FIG. 42. COAL AND ASHES HANDLING STATION OF THE UNITED RAILWAYS AND ELECTRIC COMPANY, PRATT STREET STATION, BALTIMORE.

Installed by C. W. Hunt Company, West New Brighton, N. Y., U. S. A. Power house capacity is 19,500 h. p. Tall building at the right hand is old station, and extension on the left is new, embodying all progress in power house engineering to date. No hand labor is required in handling coal or ashes, the system being automatic in all its functions.

superheater, as in the Cruse type. Cast-iron superheaters are not much in use, in spite of the many attempts made to perfect them. In Germany, where the use of superheaters has been most extensive, only one cast-iron type, the Schwoerer (Figure 33), has been successfully used, and that on account of a secret process. It is natural that a

heavily constructed superheater is more suitable to a careless boiler operation or as independently fired type.

Practice has proven that the operation of a superheater is more efficient when the steam and flue gases travel in opposite directions, thus bringing the wet steam into contact with the flue gases at the lowest temperature, while in leaving the heater the steam comes into contact with the hottest gas. This not only reduces the coal consumption but also greatly increases the life of the superheater, although a case may arise where the flue gas and steam may favorably flow in the same direction. A flue-gas temperature of 500 degrees C. (932 de-

FIG. 43. MECHANICAL DRAFT APPARATUS. HOLYOKE STREET RAILWAY CO., HOLYOKE, MASS., U. S. A.

Installed by B. F. Sturtevant Co., Hyde Park, Mass.

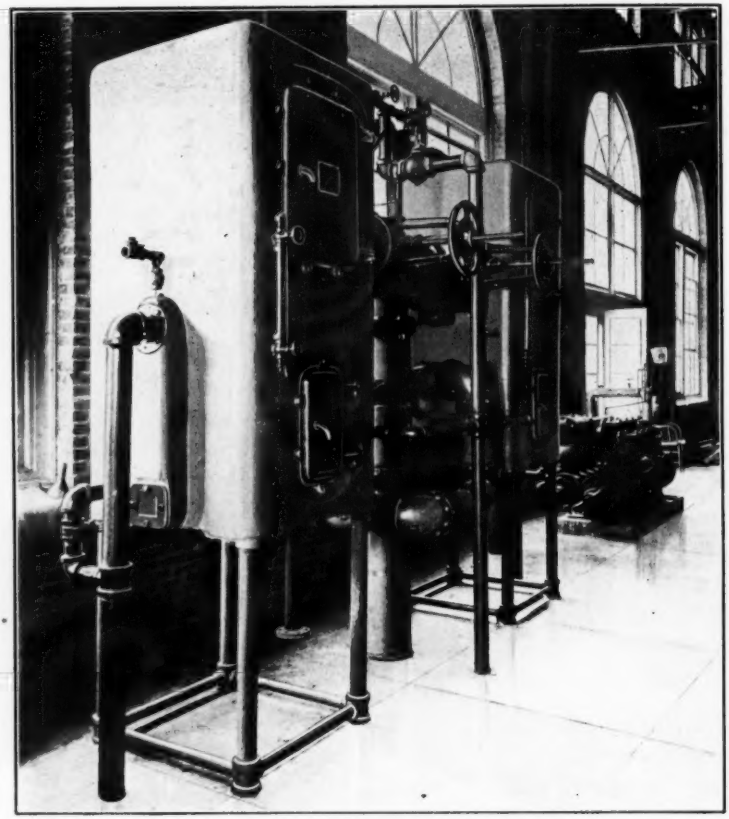


FIG. 44. WATER HEATING INSTALLATION, POWER HOUSE OF THE PENNSYLVANIA R. R. CO., CAMDEN, N. J.

Warren Webster & Co., Camden, N. J.

grees F.) may not damage a well built superheater, provided a proper flow of flue gases and steam is obtained. At 600 degrees C. (1,112 degrees F.) and higher, Berner*, probably the best authority on superheaters, recommends parallel current, or a combination of parallel and counter current.

VII. STEAM PIPES AND COVERING.

The steam mains are the arteries of the mechanical part of the plant, as the wiring is in the electrical part, and must be so designed

* Berner, Zeitschrift des Vereines Deutscher Ingenieure.

as in case of a local failure to feed the prime movers through by passes at the shortest notice. This can be done not only by installing the best fittings, but by adopting the most flexible yet short pipe system. We may consider three systems of pipe layouts, viz., the single header, the multiple header, and the ring system, the principles of which I gave in my article on steam pipes in modern power plants* as follows:-

"The single-header system usually consists of a line which is run at the back of or above the boilers, and to this are connected the lines

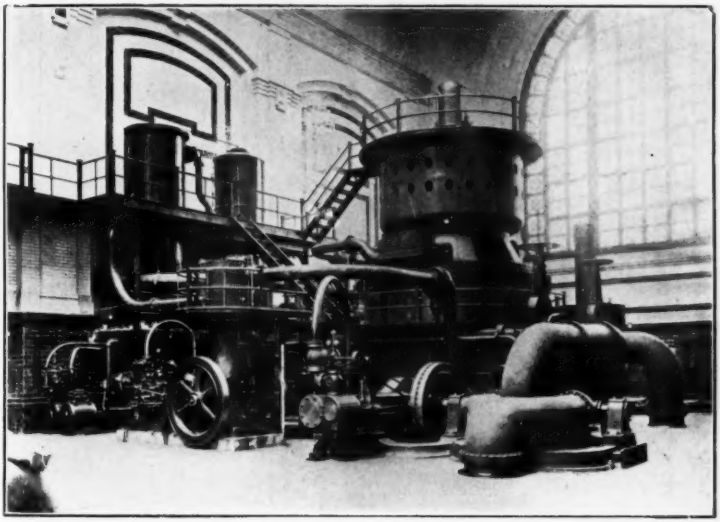


FIG. 45. 5,000 K. W.—514 R. P. M.—D-STAGE CURTIS STEAM TURBINE.
Direct connected to ATB—14—5,000—514—6,600 Volt Generator, installed at power house of the Edison Electric Illuminating Co., Boston, Mass., by the Edison Electric Company, Schenectady, N. Y., U. S. A.

from the boilers, the connection either entering at the side or dropping from above the main header. The arrangement of valves in the boiler lines is such that any boiler may be disconnected from the header at will. The steam lines to the engine or turbines are taken from this main header, usually from the top, and are thence led to the prime mover. The disposition of valves, both in the main line and in the branches, should be of a character to insure flexibility in operating and to enable the steam to be drawn from any or all of the boilers, as may be necessary, and also to enable the line to any engine to be dis-

* *The Street Railway Review.*

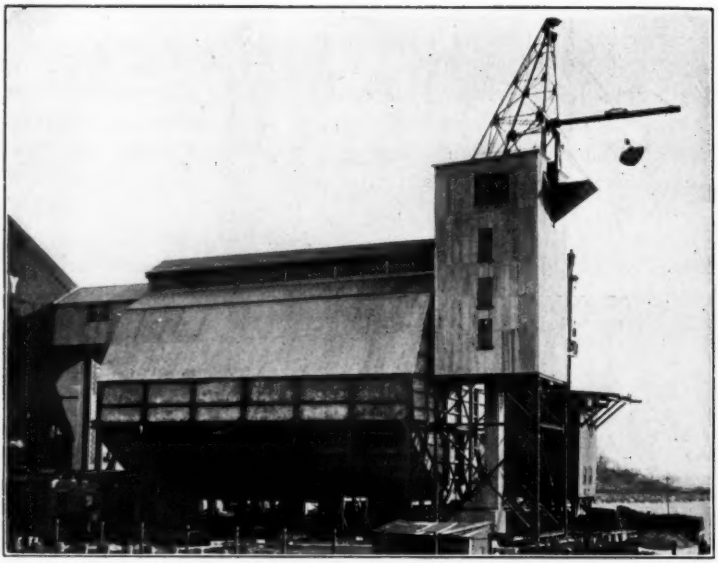


FIG. 46. COAL-HANDLING PLANT AT THE POWER STATION OF THE BROOKLYN EDISON CO., N. Y.

Plant comprises 80-ft. unloading tower, 3000-ton main storage pocket, storage bins over boiler room, electrically operated shuttle cable road with cars of 3-tons capacity, and McCaslin gravity-bucket conveyor, fed at six points and dumping automatically. Roof of galvanized iron and wire glass. The Mead-Morrison Mfg. Co., N. Y.

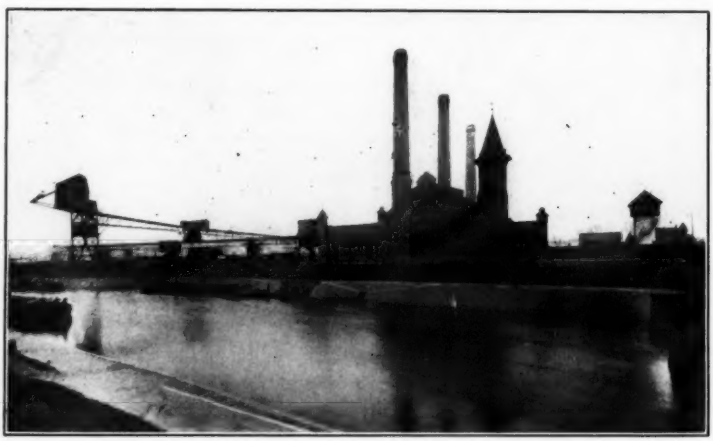


FIG. 47. BERLIN ELECTRICITY WORKS POWER STATION, MOABIT.

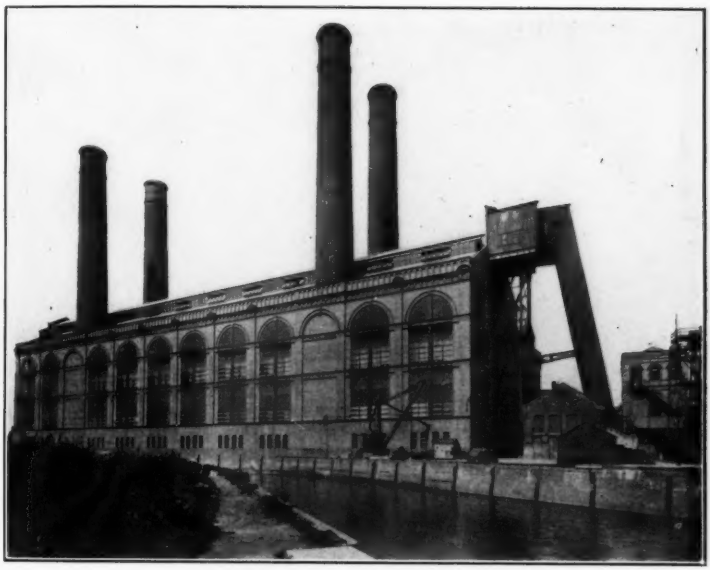


FIG. 48. CHELSEA POWER STATION, CHELSEA, ENGLAND. EXTERIOR.

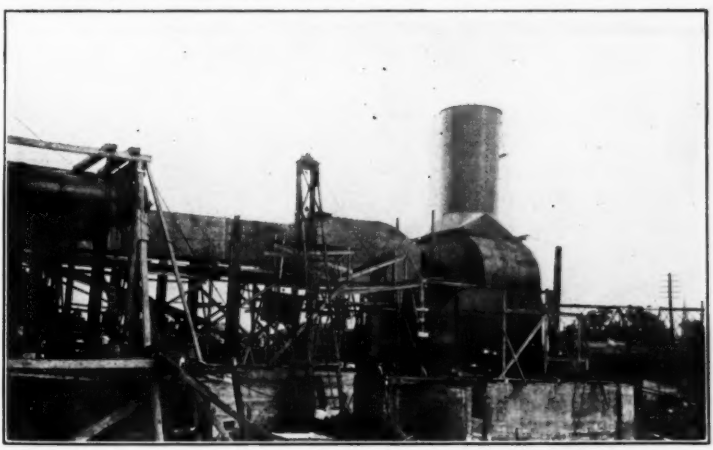


FIG. 49. INDUCED DRAFT FOR 3,000-HORSE-POWER BOILER INSTALLATION, HUDSON RIVER ELECTRIC POWER CO., UTICA, N. Y.

Can handle gases of combustion at an over-rating of 50 per cent., or 4,500 h. p. Two 260-in. full-housed fans, each with 15 by 16 horizontal center-crank engine. Inlet, 114½ in. drain, outlet, 132 by 78 in. 167 r. p. m. American Blower Co., Detroit.

FIG. 50. COAL CONVEYOR IN TUNNEL AT THE SUBWAY POWER PLANT OF THE INTERBOROUGH CO., N. Y.

30-in. belt, speed 350 ft. per minute; designed for hauling 250 tons of crushed coal per minute, but exceeds that capacity. Robins Conveying Belt Co., N. Y.

connected at will. The general character of this system is well known and needs no further description. On account of the extreme simplicity of this method it is very largely used. The pipe connections to and from the super-heaters are also given.

"The multiple-header system consists of two or more headers to which the connecting pipe lines from the boilers are joined, and from which branches are led to the engines. The general arrangemnt of this system is shown in Figures 3 and 4, and from these diagrams it will be seen that the arrangement of connections is a remarkably flexible one, and that the method provides as far as possible against accident to any part of the pipe line. Two possible methods of cross-connecting are shown in these illustrations, and it will be seen that in the right-hand method flexibility is purchased at the cost of numerous valves and fittings. It is, of course, apparent that there are almost an infinite number of ways in which the multiple headers may be cross-connected, but in any event the object of this system is to provide an extra header to carry the load in case of an emergency, and the best method of cross-connecting is that which utilizes the minimum number of valves and fittings and at the same time is the most flexible.

"The general arrangement of the ring system is to construct the main

steam header in the form of a closed ring. This ring may be split up into sections by means of suitably placed valves. There are numerous variations possible with this arrangement, as where the header runs around both sides of the boiler room the two sides may be cross-connected at desirable points, or where the two sides of the ring are close together, and, on account of the effect of expansion in a short cross-connection, the two lines are only joined at the ends by short bends."

Pipe sizes should be chosen as small as possible without ill effect, since small pipes are cheaper, lighter, and more convenient.

In American practice the velocity of the steam in the main does not usually exceed 6,000 feet, or about one mile per minute, while in Europe the velocity is often as high as two miles, on account of the use of superheated steam. Superheated steam is a more perfect gas and is not so easily affected by friction at elbows, bends, valves, etc.; therefore the loss in pressure is much less than in the case of saturated steam, of which the specific gravity is much greater. On account of these qualities it is much easier to convey superheated steam at greater velocity than ordinary steam, and therefore smaller pipes may be used. It may be of interest to give the following examples show-

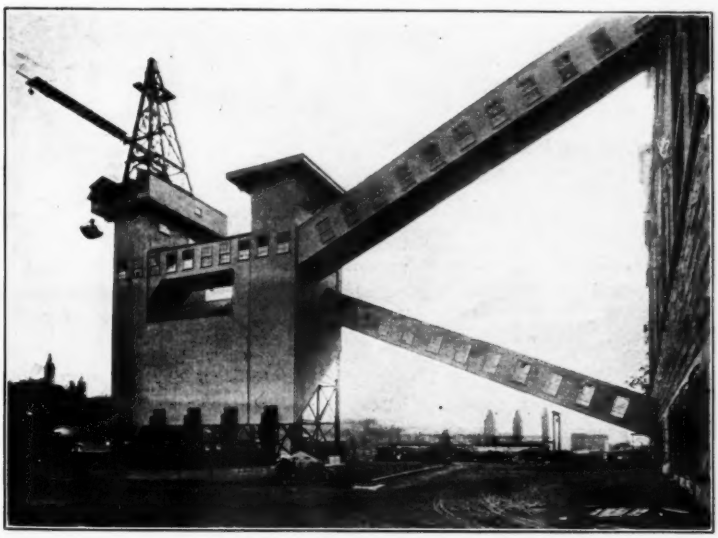


FIG. 51. KINGSBRIDGE POWER PLANT OF THE THIRD AVENUE RAILROAD CO., NEW YORK.
Hoisting and conveying apparatus designed and installed by the Robins Conveying Belt Co.

ing the marked difference between the practice in America, in England and on the Continent. The four 5000-kilowatt Brown-Boveri-Parsons turbines in the St. Denis plant, Paris, are each supplied by one 12-inch steam pipe. The 5,000-kilowatt Westinghouse Parson turbines in the Chelsea plant, London, are suplied by 14-inch pipes. The 3,400-horse-power Sulzer engines in the Vienna stations are supplied by 8-inch pipes. On the other hand, the 8,000-horse-power Allis Chalmers engines in the power plants of the Elevated and Subway roads in New York are each supplied, as they are four-cylinder cross compound, by two 14-inch pipes. At the last mentioned station there are two Westinghouse marine type engines, supplied by 8-inch mains. A better showing is made by the recently erected Westinghouse-Parsons and Curtis 5,000-kilowatt turbines at different stations, each of which is supplied by one 14-inch main.

With the adoption of high pressure up to 200 to 300 pounds, and superheated steam up to 500 degrees or 750 degrees F., and even higher, it will be seen that the old standard fittings are no longer of value for modern power-plant practice. Thus it happens that many prominent power-plant engineers in the United States have adopted their own fittings, especially flanges. It is very different on the Continent, where the Verein Deutscher Ingenieure has adopted standard flanges for pressures up to 20 atmospheres per square centimeter (294 pounds per square inch) which have today been accepted through practically the entire Continent. These standards include many different designs. Those mentioned below are the most favored. The dimensions in the accompanying table suitable for 300-pound pressure, originally given in metres, have been changed to read in inches and fractional parts, and have been slightly increased over what the converted dimensions would be, to do which the author has laid out each individual size of flange. Also well known and quite extensively used are the tongue-and-groove joint and a lens joint, the latter having a round gasket. The lens joint may be practically adapted either for the use of a gasket or for a ground steam-joint. The ground joint is more common in America than in Europe, where grooved joints fitted with gaskets are favored. The re-enforced end of the pipe is of the same material as the main pipe, and welded on. Tight joints are always attainable by use of any of these types.

A table of flanges compiled by Mr. John Van Vleck, has been adopted by the Interborough Rapid Transit Company and also by several other engineers. These flanges are designed for the use of ground joints only.

	Pressure in lb.	Pipe Size, inch.	Flange Diam., inch.	Thickness, inch.
Verein Deutscher Ingenieure.....	300	8	14¼	1⅝
American Society of Mechanical Engineers	250	8	15	1⅝
Interborough Rapid Transit Co.....	250	8	16¼	2

The practice of using drawn or seamless welded wrought-iron or steel pipes for conveying steam is old, and the elasticity necessary on account of expansion and contraction, especially with the use of superheated steam, is well-known. In place of the old type of cast-iron elbows, long sweeping bends, generally of a radius not less than five times the pipe diameter, are now installed. Cast-iron or special

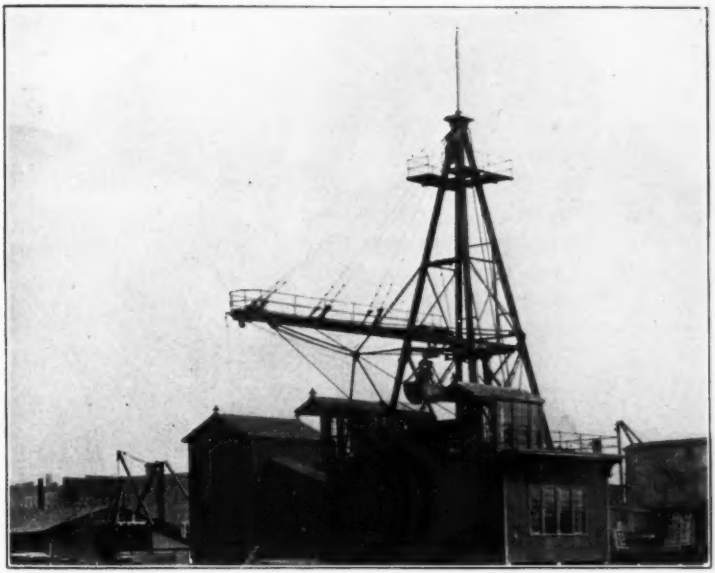


FIG. 51. ELECTRIC HOISTING TOWER AT SUEWAY POWER HOUSE, NEW YORK. Erected by the Robins Conveying Belt Co.

steel fittings are still in use where the space is limited, or when fittings of special design are required. In Continental plants one will quite often find these fittings replaced by welded ones, which are obtainable for any desired pressure, size, or pattern, with either fixed or moveable flanges. For example, steam collectors, with some dozen nozzles, or complicated pipe headers, and elbows similar to small standard cast-iron types, are welded as if made of a single piece. The material for these fittings is usually either Siemens-Martin or Thomas steel. Harder plates may also be welded for this purpose, but their use is

limited. These different welding processes are carried on by a great number of firms, and are no longer secret.

Continental pipe designers, in choosing pipe lengths, are not so much handicapped as in the United States, where pipes a trifle more than 20 feet in length are the longest obtainable. They can obtain pipes up to about 50 feet in length without special difficulty. The advantages of avoiding numerous flanges and of using fittings as above mentioned, of the same material are well realized by men experienced in this line.

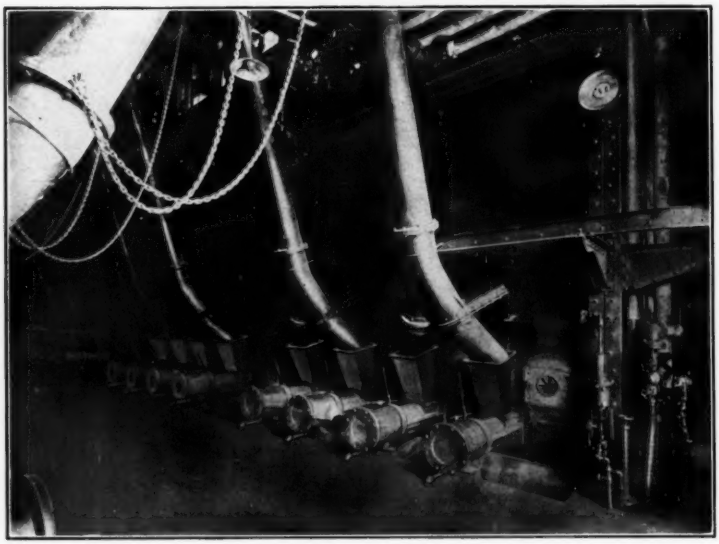


FIG. 52. COMMERCE ST. STATION, MILWAUKEE ELECTRIC RAILWAY & LIGHT CO.

Jones Stokers supplying Edgemoor water-tube boilers of 650 h. p. each. An additional equipment of 32 Jones Stokers is being supplied to this station. The combined plants of this electric company have 11,200 h. p.. The Underfeed Stoker Co. of America, Chicago.

As already stated, the pipe lines connecting boilers with prime movers must be as short as possible. As in modern engineering practice and with the improvements in material the liability to breakdowns has been reduced to a minimum, a single common emergency line (header) should prove satisfactory. It is of the greatest importance though seemingly often overlooked) to cut *dead* all lines not required for the direct operation of the engines in order to avoid any unnecessary condensation; by so doing we may materially increase the econ-

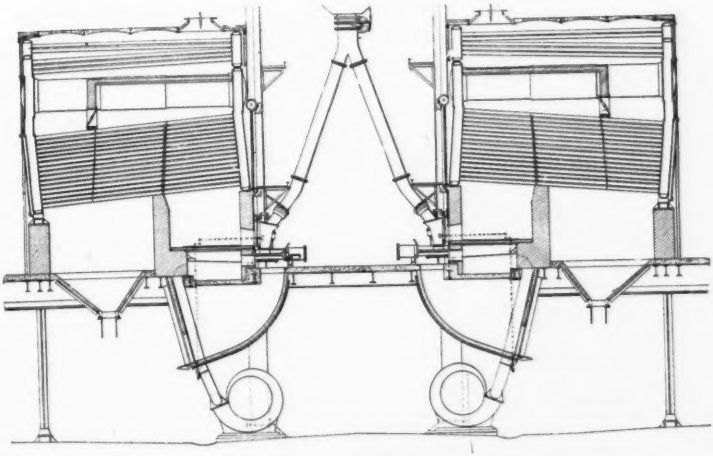


FIG. 53. CROSS SECTION SHOWING INSTALLATION OF COAL-CONVEYING AND ASH-HANDLING MACHINERY IN CONNECTION WITH MECHANICAL STOKERS.
Commerce Street Plant, Milwaukee Electric Railway and Light Co.

omy of operation. A header is an emergency member and should be used at no other times.

It is interesting to note the length of steam pipe installed in the New York Subway plant.* Figuring the present plant of ten 7,500-horse-power engines, 6,500 feet of main steam pipes are installed, about 2,000 feet of which constitute the so-called "equalizing system" similar to three headers, the purpose of which is to equalize the pressure over the entire plant. For operating this plant 1,000 feet of live steam pipes have been added for supplying the auxiliaries. This gives 0.1 ft. per normal horse-power.

To provide the steam main with a quick-closing valve is good practice. The Germans are forced by law to install self-acting cut-off valves, with which, in cases of accident in a particular main line, the steam is automatically cut off. This is often accomplished by introducing a valve containing a ball of larger diameter than that of the pipe. Under ordinary circumstances, the steam (the velocity of which is capable of regulation at the valve), travels over the ball; in case of rupture in the pipe the increased velocity raises the ball pushing it against the outlet. This of course is not a tight cut-off, but it prevents the bulk of steam from escaping. Highly satisfactory results have

* Franz Koester, The Engineer, Dec. 1, 1904.

been obtained by the adoption of this device, and it may have saved many a life.

Conveying steam through a pipe main necessitates a certain loss of heat. Experience has proven that the higher the pressure or hotter the temperature the smaller the comparative loss of heat, and therefore superheated steam is not as much affected as saturated, although nearly all tests made on superheated steam report that they were able to draw off condensed steam from the main. This, as Dr. Berner reports in *Zeitschrift des Verein Deutscher Ingenieure*, is due to the lower conductivity of superheated steam, which plays a great role in this respect.

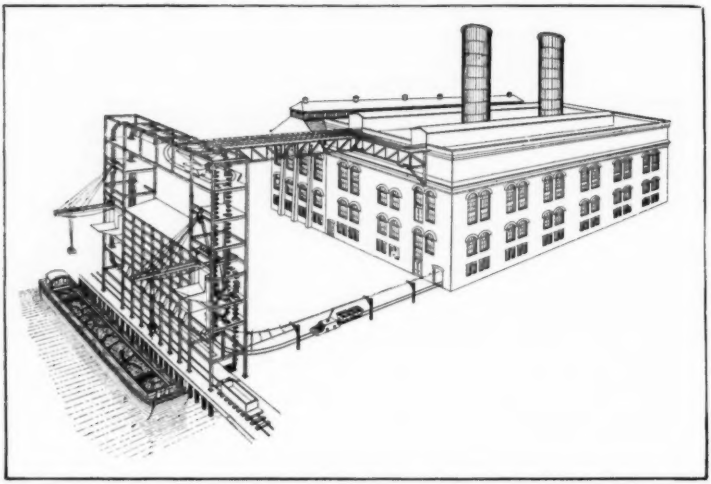


FIG. 54. COAL AND ASHES HANDLING SYSTEM, WILLIAMSBURG POWER STATION OF THE TRANSIT DEVELOPMENT CO., OF BROOKLYN.

Two unloading towers, similar to those in the Edison plants, with coal crushers, two McCaslin conveyors, cable road for distributing coal in bunkers and ash tracks with electric locomotives. Capacity, 250 tons an hour. The Mead-Morrison Mfg. Co., N. Y.

The loss of heat is dependent upon the character of the pipe, the material of the outside surface, and the temperature drop between this surface and the surrounding air. A great part of the condensation may be prevented by covering the pipe with non-conducting material. Many different substances are used for this purpose, but none of them can entirely prevent the condensation. Tests made by Professor Rietschel in connection with the high-pressure distance heating plant of Dresden show that felt and raw silk are the best insulating substances, but owing to their inflammability they are unsuitable with

high degrees of temperature. He therefore suggests first plastering the pipe with "kieselguhr (an earthy substance) then applying the mentioned materials. Pasquay has obtained very satisfactory results by surrounding the pipes with air jackets. Rietschel, who also experimented with this system, suggested the dividing of these jackets into small chambers to prevent the circulation of air. The pipes of the above mentioned Dresden heating system, about one mile long, are covered with jackets of perforated sheet iron, over which a layer of raw silk is wound, all of which is enclosed in a second similar jacket. Professor Rietschel, by further experiments, also suggests the covering of the pipes with a mixture of plaster and organic material, which latter, on account of the heat, will burn out leaving small air spaces. Perhaps one of the most complete series of experiments for obtaining the value of pipe-covering materials was made by Stott* at the New York Elevated power plant. These tests were made preliminary to the letting of the contract for pipe-covering materials. The results of these tests prove that the saving of heat with different materials varies from 78.4 per cent. to 89.4 per cent. The latter, with a 2-inch pipe, was obtained with 2½-inch covering composed of 85 per cent. carbonate of magnesia, ½-inch blocks, about 3 inches wide by 18 inches long, next to the pipe and wired on, over which were placed solid 2-inch moulded coverings, the outside being finished with 3-ounce canvas pasted on. Berner remarks on this that these results are higher than have been obtained elsewhere with either steam or water. Care should also be taken to prevent radiation from the covering, which may be done by keeping them white or covering them with galvanized sheet-iron plates.

* Convention of Association of Edison Illuminating Companies, at Mt. Washington, N. H., Sept. 9, 10, 11, 1902.

THE DOCKYARDS AND SHIP-BUILDING PLANTS OF JAPAN.

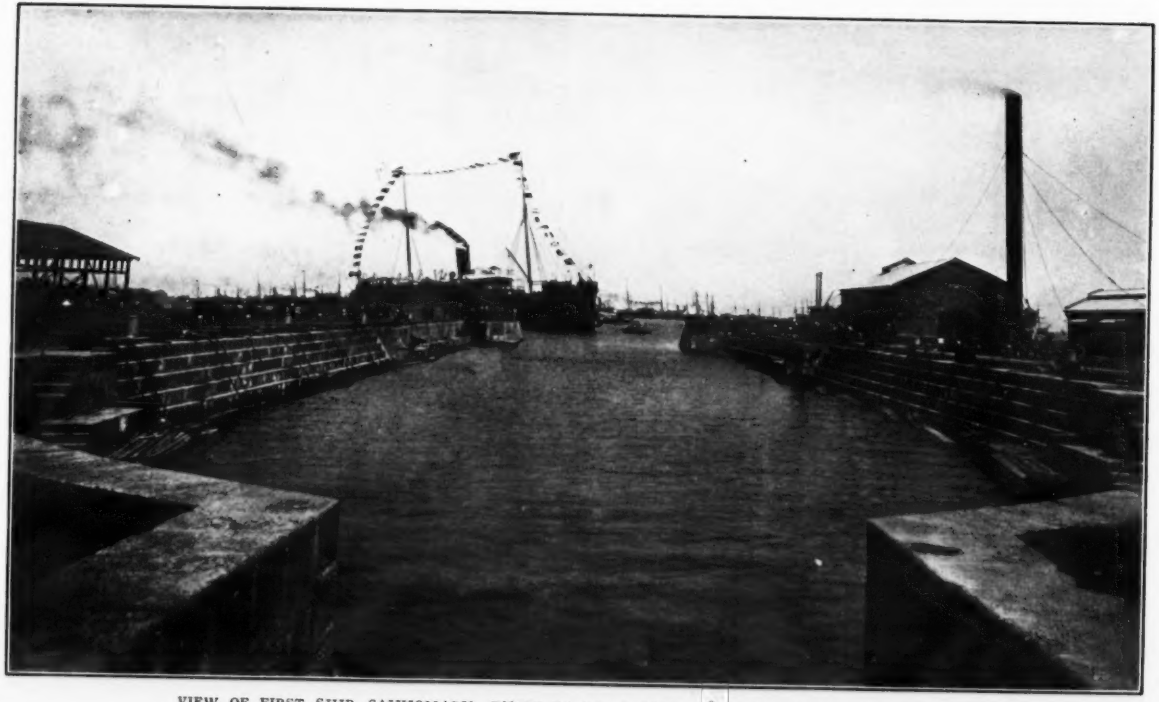
By Chas. Albertson.

Recent history has made any study of Japan's industrial resources and future a matter of keen interest. This interest appears in a new light when it is regarded in connection with the changed relation between the Orient and the Occident which will be established by the opening of the Panama Canal. Mr. Albertson's long and intimate familiarity with engineering matters in Japan enables him to present the subject with authority and discrimination. This first paper, dealing with the general conditions and the Government yards, will be followed by a second, treating more fully still and with fuller illustrations of the private ship-building yards of the Island Empire.—THE EDITORS.

THE Japanese are quartered on a long, narrow, very mountainous group of islands having an area one-third larger than the British Isles and about equal to that of California, of which only 12 per cent is capable of cultivation. The dense population of from 45,000,000 to 50,000,000, all dependent upon the products of the field and the nearby waters, carry on their outdoor work by many an ancient method. Their struggle for existence has not been an easy one. Yet with all this they are contented and happy, for the struggle has not been characterized by the haste and intense strain under which we labor. In this respect they are wiser in their day and generation than we are.

When considering Japan's progress it is well to remember that there are at least two view-points. One is the Japanese; and if we judge by their notions, the advancement during the time occupied by the last half of Marquis Ito's public life alone is little less than marvelous. This is the point of view persistently put forward by them and oftenest seen in newspapers. On the other hand, from the outlook of a foreigner who has lived in Japan and knows the average as well as the exceptional conditions, they still have a long way to go in their industries and civilization to attain the eminence they are popularly given credit for having already reached.

Japan progresses. Her ship-building progresses also. So do her other industries. Were it possible, a hasty glance along a few other lines of Japanese industry would be of interest as showing in a general way the past and existing conditions and the present state of



VIEW OF FIRST SHIP, SAIKIOMARU, ENTERING NO. 2 DOCK, 1897. YOKOHAMA DOCK CO., LTD.

progress. This comparison of industrial works should give the relative progress and position of ship-building as compared with the improvement and present standing of other industrial enterprises. It would also emphatically evidence the fact that Japan's industrial growth has not been in ship-building alone, but that her progress has been along all lines, and therefore that ship-building has only been keeping pace with the national progress.

We may only state that in coal, copper, gold, and other mining she is using up-to-date appliances with good results. In the matter of electric street railways, her urban and interurban systems are well equipped and well paying. Her steam railroads have been extended and improved, and the rolling stock and shops are in good condition. The postal system is a credit to the nation. The telegraphs and telephones are efficiently conducted at rates about half of what we must pay in this free country. Cotton spinning and weaving mills are successfully run. Electric-light and power plants, operated some by steam and some by water, are starting up in all advantageous places. Gas plants are being built, and the large cities are already supplied with excellent water works. And so on through the whole line of enterprises there is progress and success.

Even yet, in the matter of competition, the ship-building capabilities of the Mikado's Empire are not large enough to be of intense interest or much concern to the mighty ship-building nations of the earth. However, since Japan is creating an interest in herself by rapidly forging ahead and properly taking her place in the family of nations, all that directly pertains to her growth and welfare must sooner or later interest the other nations. Moreover, because of her insular and isolated position, she herself is mightily interested in and may later be more dependent upon her ship-building interests, both industrial and as a means of defense.

National pride is a strong Japanese characteristic, and hence while there is no especial antagonism against the foreigner the Japanese earnestly desire to get all industries in their own hands and then be independent. This desire will be a long while in seeing its fulfillment, for we are none of us independent.

Rear Admiral Sasao, director of the Naval Construction Corps, said in an address two years ago that "It is, perhaps hardly necessary to point how important it becomes to promote other industries connected with ship-building, in order that we may drive out foreign-made goods altogether from ships built in this country." A Japanese engineering journal voices the same sentiment, a native translation

SCHOOL AT MITSU BISHI DOCKYARD AND ENGINE WORKS.

of which follows:—"It is to be extremely regret that there still imported from abroad for larger ships, but it is very joyfully for these Japanese ship-building business were incidentally improved by each every year."

It is well to keep continually in mind the fact that Japan has done but little or nothing to add to the science of ship or engine building. Other nations have learned nothing new from her along these lines, yet this should not detract from the credit due her on account of her splendid advancement.

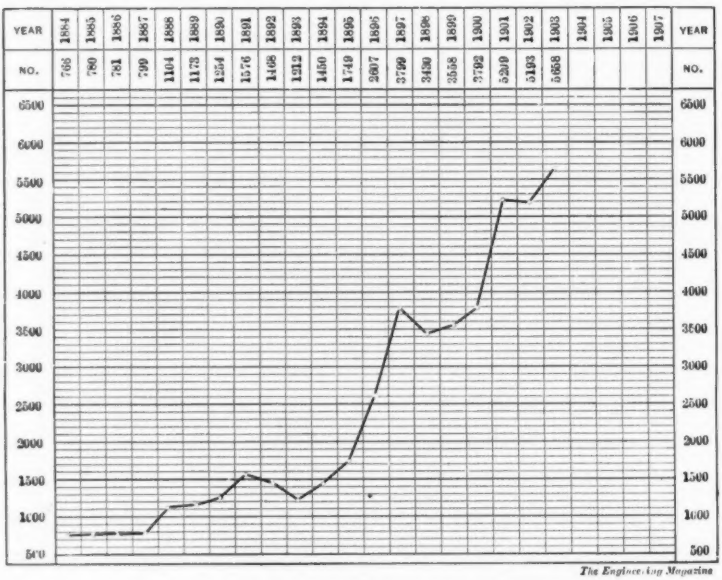
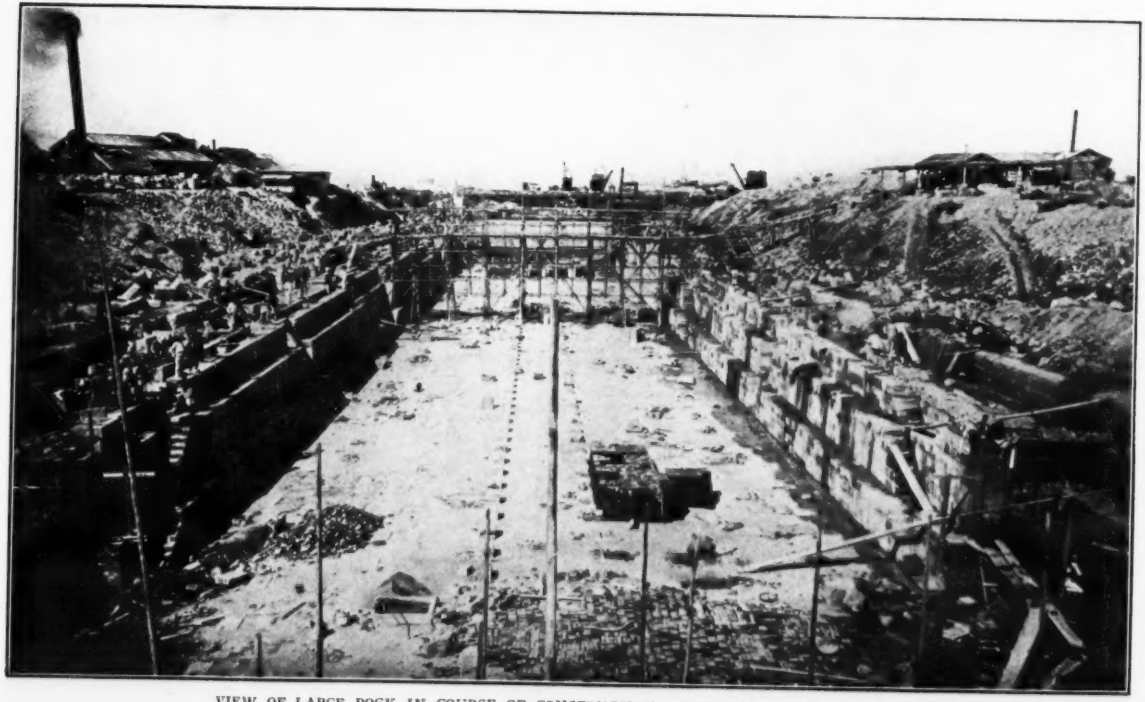


DIAGRAM ILLUSTRATING NO. OF WORKMEN EMPLOYED IN SHIPBUILDING 1884-1903 INCLUSIVE IN JAPAN. CENSUS TAKEN EACH YEAR.

Her problem is the adaptation of the present knowledge of other peoples to her own use, and the training of men to use this knowledge for her benefit. This in itself is a large undertaking, but the results show strikingly how well it has been accomplished. She did not start with the old-fashioned paddle-wheel steamer and its primitive machinery, but jumped at once from the wooden junk to single-and twin-screw steamers with compound and triple-expansion engines. She has been compelled to develop men rather than machinery. Even with the advantage of starting way up the ladder of science, she still



VIEW OF LARGE DOCK IN COURSE OF CONSTRUCTION. YOKOHAMA DOCK CO., LTD.
Typical Japanese dry-dock construction.

has many, many rungs to climb in order to reach the height attained by other nations. That she is climbing, and climbing well, everyone admits.

It is a curious fact, worthy of note, that Japanese thought and language contain absolutely nothing in the way of words, or parts of words that could be pieced together, to express modern ship-building and marine terms. They have therefore borrowed outright most of the English technical terms, and use these, although at

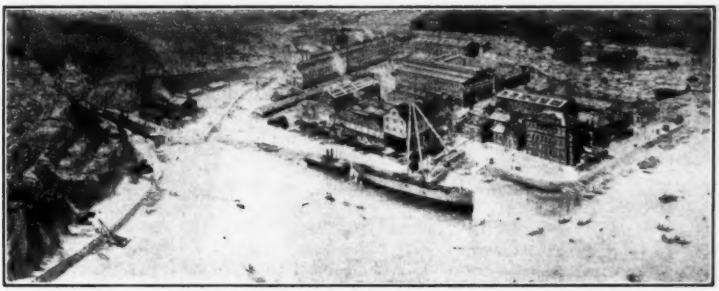
THE MITSU BISHI DOCKYARD AND ENGINE WORKS. HALF VIEW. COMPLETED ON OPPOSITE PAGE.

the Mitsu Bishi works a few old Dutch words linger in use. Even on shipboard a Japanese captain gives his commands in English. All this helps to show how very new and strange ship-building and its component industries were to the Japanese.

If one could be dropped unawares into a modern Japanese shipyard, with eyes blindfolded and the peculiar sounds of the Japanese language kept from the ears, the sensation produced would be exactly similar to stepping into an English or American shipyard, for the clatter of pneumatic caulkers, riveters and chippers, the rattle of plates, the grinding of punching and shearing machines, the thud and jar of steam hammers, the whir of motors, the crunching of hydraulic machines, and the racket and rumble of hammers and machine tools generally all conspire to give one the same feeling of progress and activity in the various departments that would be experienced in the home land. The appliances are the same, the result is the same; but the work is being done by a different nationality—one that is strictly Oriental, but nevertheless one that is versatile enough to take up the best that all nations have to offer.

About three-hundred years ago, Japan was one of the most progressive, vigorous, and powerful of all the maritime and ship-build-

ing nations of the Far East. So apt were her seafaring people at designing and building the then great ships that she developed a fleet of fast three-masted junks which outsailed the ships of China, Korea, and all other Eastern nations. This superiority in the matter of speed, besides building up a great sea trade, soon produced a class of pirates who plundered everything upon the high seas. Complaint after complaint from other nations reached the ruling Shogun at Yedo. For this and other reasons an edict was finally issued forbid-

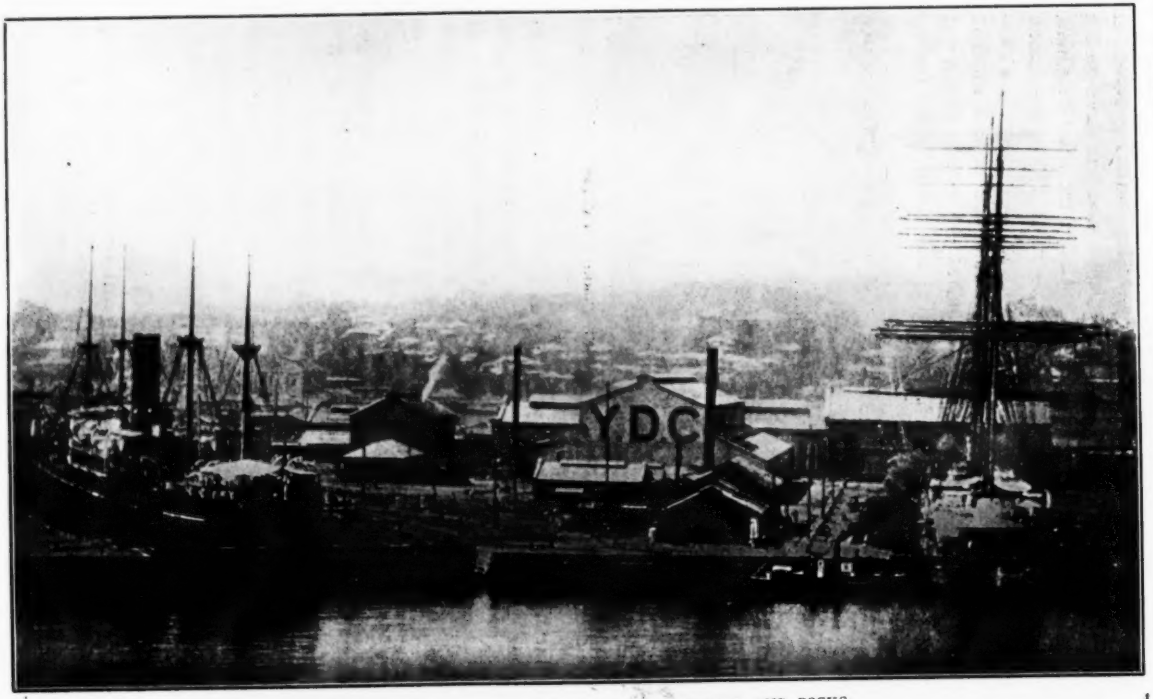


VIEW OF MITSU BISHI DOCKYARD AND ENGINE WORKS. COMPLETED FROM OPPOSITE PAGE.

ding the building of junks having more than one mast. From that time even to the present day, many of these picturesque though awkward, one-hundred ton junks sail the island-dotted waters of Japan. A later law giving full freedom to ship-building favors a type of foreign schooner rig, and soon the big, single, square sail will be seen no more.

Under a wiser *regime*, her summarily arrested development has taken on a new start and a new form, for today she builds in steel and sails by steam. It is no news that Japan is making a mark in the great world, and to ship-builders and associated industries it will doubtless be of interest to know what may be expected of the Little Sea Realm in an industry upon which she is so dependent. England goes surely and steadily onward in the yearly construction of vast maritime fleets and great navies of peace-keepers. Germany has startled the marine world by her strides in the same direction, and lately the United States has surprised the globe with the work of her new and old shipyards, particularly as evidenced in the small though unexcelled home-built navy.

It will be the purpose of this review to show exactly and accurately what Japan has been and is doing, how well she is doing it,



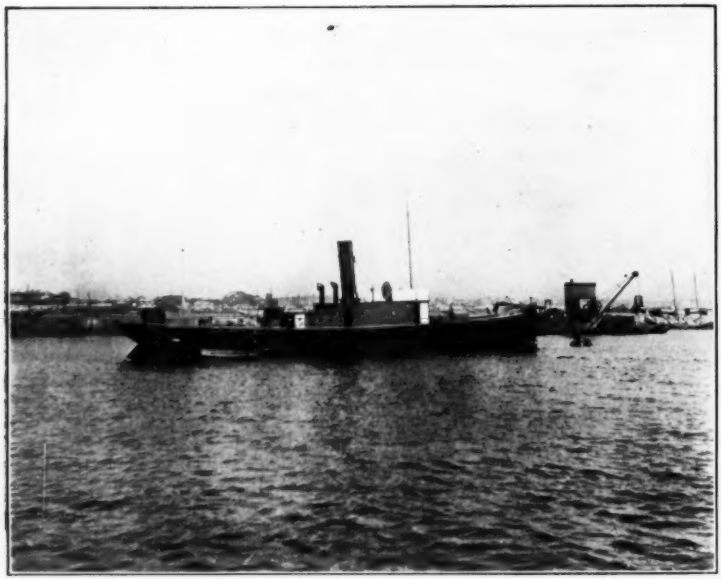
YOKOHAMA DOCK CO., LTD. GENERAL VIEW OF WORKS AND DOCKS.

YOKOHAMA DOCK CO., LIMITED.

Barque Asterisk in No. 2 Dock, 374 feet long.

the difficulties under which she labors industrially, and her dependence on other countries for material; then a reasonably correct forecast of the future may be made. A complete description of yards, their equipment, output, management, and labor conditions, together with a statement showing how the demand arises for repairs and ships, will therefore be pertinent and necessary to the subject.

A general survey of Japan's ships and shipping shows that in 1870 the Japanese owned about 17,000 tons. Before the war with China there were under the Japanese flag a total of 225,000 gross tons. At this time the Japanese mercantile marine carried about one-tenth of the total exports of the empire. At the end of 1903, the number of vessels above 20 tons registered in Japan was 1,088 steamers, having a gross tonnage of 657,269, and 3,514 sailing vessels, mostly junks, with a gross tonnage of 322,154; or, in all, 4,602 vessels having a gross tonnage of 979,423. These figures include foreign-built as



TWIN SCREW TUG TOBEMARU; 100 FEET LONG, 300 I. H. P. YOKOHAMA DOCK CO., LTD.

well as Japanese-built steamers, for in order to carry the Japanese flag they must belong to the Japanese.

In 1902, 23,000,000 tons of shipping entered and cleared at Japanese ports, of which more than one-third was under the Japanese flag.

For ten years ending 1903, the average tonnage of Japan's steamers increased from 180 tons to 650 tons. Since the ship-building subsidy act of 1896 there have been built in Japan about 40 steamers qualified to receive the subsidy benefits. These range in size from

713 tons to 6,444 tons, gross, making a total of, roughly, 100,000 tons, having a total of about 83,000 indicated horse power. The speeds vary from 10 to 15 1-3 knots.

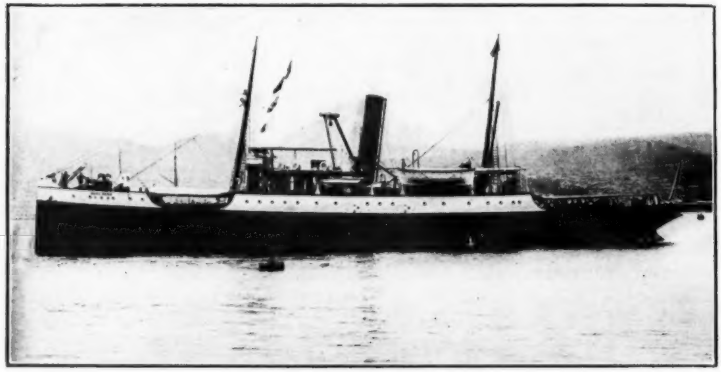
In 1893 Japan built 26 steamers totalling 4,000 gross tons and bought 10 steamers totalling 13,000 gross tons. In 1903 she built 65 steamers of 33,600 gross tons, and bought 17 steamers of 33,400 gross tons. It will thus be seen that during this period there has been a decided increase in both the number and tonnage of ships built at home, while the purchase of ships as compared with those home-built is gradually decreasing.

A SMALL JAPANESE SHIPYARD, BUILDING SAMPANS AND JUNKS.
The situation is typical of much of the coast of Japan.

Ship-building materials are imported from England, America and Germany principally. Contracts for delivering these articles at the shipyards are awarded, after tender, to various importing Japanese and foreign firms who buy through their home offices. The Mitsu Bishi Company, however, purchase mostly through a representative in England who buys their supplies on a small commission.

With the exception of possibly some small lathes and other minor tools for use in the little yards, Japan still imports all her ship and engine-building, dockyard, and repairing equipment. It does not take long to state this but it is worth some attention.

From pig iron to unfinished teak, from stem-post to stern-post, at least 90 per cent of the material for building ships in the Japanese



SALVAGE STEAMER OURA MARU.

Built under the Teishinsho Rules and Lloyd's special survey, class 100 AIMC. Material, Steel. Length, 186'. Breadth, 29'. Depth, 16' 2". Mean Draft, 11' 6". Gross tonnage, 712 tons. Speed, 12¼ knots. Engines, Triple expansion. Horse power, effective, 700. SALVAGE GEAR. 3 12" Centrifugal pumps, 1 18" Centrifgal pump, 3 Pulsometers, 1 15" Special pump.

yards is imported. This is also worth some attention. Some of this, of course, arrives in the raw and is finished or made up at the yards; but many smaller items, such as deck machinery, pumps, fittings, etc., are imported complete. To order and deliver these supplies takes time, so that short delivery after placing a contract is impossible. All this, with labor cheap in price but not altogether efficient, shows that she is not the best favored nation in the world in regard to ship-building. Builders and owners must therefore depend on the assistance of subsidies for a long time to come.

If she had a good supply of iron ore—which she has not—there would be then some hope of changing the present unfavorable conditions. One opportunity for improvement lies in increasing the efficiency of her labor without an undue increase in wages.

Longing for industrial independence, and also to meet the home demand for plates, shapes and rails, the Government has established a steel plant in Yawatamachi, near the western entrance to the Inland Sea, capable of turning out 80,000 tons a year. The works import the nearest iron ore from China, and as Japanese coal is not "A-1" for coking purposes they cannot be operated under the most favorable conditions. At the first the output was not satisfactory, and even today the builders prefer, for quality, an imported plate with Lloyd's test to one made in the only home works.

In 1893 there were in Japan about sixty ship-building yards. In

1903 this number had increased to one hundred and eighty-five. It must be borne in mind, however, that every place capable of building an ordinary junk is included in this number, and that the ship-building yards which are really of moment to the foreigner can be counted on the fingers of one hand.

Descriptions, some general and some in detail, will be given of enough of the private ship-building and dry-dock establishments to show the general character of all of them. Those of most interest include the Mitsu Bishi Dockyard and Engine Works, Nagasaki; the Kawasaki Dockyard Co., Ltd., Kobe; the Yokohama Dock Co., Ltd., Yokohama; the Ishikawajima Ship-Building and Engineering Co., Ltd., Tokyo and Uraga; Osaka Iron Works, Osaka; Hakodate Dry Dock Co., Hakodate, Hokkido; the Bingo Dry Dock Co., Province of Bingo; the Innoshima Dockyard Co., Province of Bingo.

Other than the largest companies mentioned above, there are five which own docks more than 250 feet in length, and three owning docks more than 200 feet in length.

Government Ship and Dockyards. Of the Imperial Government Naval Dockyards only a few bare facts dare, with propriety, be given. These yards are four in number.

One is at Yokosuka, nicely inside the entrance of Tokyo Bay, and has three good dry-docks. Here can be easily docked the largest battleship afloat. Among the war vessels constructed here may be mentioned the four largest, namely, the "Hashidate," an unarmored cruiser, 301 feet by 51 feet by 20 feet, of 4,200-tons displacement, a designed horse power of 5,300, and a speed of 16 knots, which was launched in 1891; the "Akitsushima," an unarmored cruiser, 300 feet by 43 feet by 17 feet 6 inches, of 3,100-tons displacement, a designed horse power of 8,400, and a speed of 19 knots, was launched in 1892; the "Niitaka," a third-class unarmored cruiser, 335 feet by 44 feet by 76 feet, of 3,366-tons displacement, a designed horse power of 9,400, and a speed of 20 knots, was launched in 1902; the "Otawa," a third-class unarmored cruiser, 321 feet 6 inches by 41 feet 3 inches by 15 feet 9 inches, of 3,000-tons displacement, a designed horse power of 10,000 and a speed of 21 knots, was launched in November, 1903.

Leaving out torpedo-boats and torpedo-boat destroyers, these vessels constitute half the total tonnage of warships turned out in all Japan, and comprise two-thirds of Yokosuka's tonnage. They are also the largest ever built by the Government in the Island Empire. This shows clearly how small a part of the Imperial Japanese Navy is home-built, since official records show that Japan has between 45

and 50 war-vessels of over 1,000-tons displacement, approximating in all 250,000 tons.

Another of the Naval yards is at Kure, hidden safely away among the islands on the north shore of the Inland Sea. Here are two dry-docks and here was docked the American battleship "Oregon" when the Russians claimed that the Port Arthur dock was too small.

The "Tsushima," a third-class unarmored cruiser, 334 feet 9 inches by 44 feet by 16 feet 3 inches, of 3,400-tons displacement, a designed horse power of 9,400, and a speed of 20 knots, was launched here in 1903. The recent exhibition in Osaka had on view a 10-inch gun made at Kure, as well as a full line of smaller arms and a very complete set of steel castings. These were the work of the Arsenal Department. Armor plate has not as yet been manufactured in Japan, but appropriations have been made for a complete armor-plate plant to be installed in the Kure yards.

Sasebo is another, though considerably smaller, naval yard, located at the end of a long, narrow bay on the southwestern coast of Japan. Here they have one large dry-dock.

Maizuru is the newest of the yards, and is situated on the northern or Japan Sea side of the Empire. Here, too, they have a splendid dock.

All of these yards are so located and fortified that it would be almost impossible for a foreign navy to get anywhere within range of them. The Japanese, to a greater or less degree, build torpedo-boats and destroyers, of which they have added many to the navy.

The preparedness and excellent condition of His Imperial Japanese Majesty's Navy in its recent battles prove conclusively that these yards are well equipped and mighty efficient. A following article will give a comprehensive idea of the private ship-building plants, concerning the plans and equipment of which fuller details may be presented than is possible in the case of the Government installations.

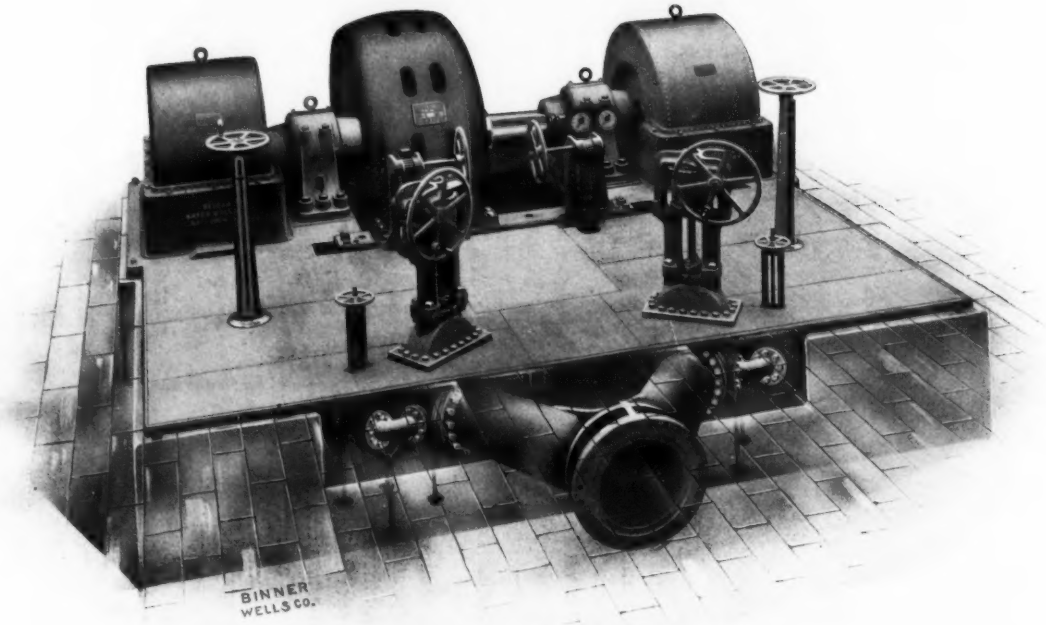
HYDRAULIC GENERATION AND APPLICATION OF MOTIVE POWER—WATER POWER INSTALLATION.

By William M. Barr

WATER power installations for generating light, heat and motive power are competing sharply with steam engines in large plants, and also with gas engines in medium and smaller installations; but a water power development to be successful as a commercial enterprise must have certain possibilities. There must be a market for the power; the cost of the power must be no greater and should be less than could be furnished by steam; the water supply must be constant throughout the year.

The minimum flow of creeks and rivers is not the same throughout the country. Some rivers have their lowest flow in the winter, others in mid-summer. The water powers of New England have been well exploited, and the peculiarities of flow are well under control. The Southern Appalachian region, is represented as having water-power opportunities which, when developed, will exceed in value the more important coal fields which they contain. The French Broad River, draining a thousand square miles of territory, which falls 900 feet in its course, never rising more than seven or eight feet during the worst floods, is an example.

The size of any proposed hydraulic power plant will depend upon the use to which it is to be put. If the power is to be applied where generated, as in the case of a mill located alongside a stream furnishing the supply, a size of wheel will be selected to furnish the power necessary for a fixed output of merchandise which may utilize but a small portion of the available energy, and no special care need be exercised as to the minimum volume of water during the dry season, provided the stream does not then become wholly dry. If the demand for power be such that all the available energy can be utilized, then a careful survey of the water shed must be made. A preliminary sur-

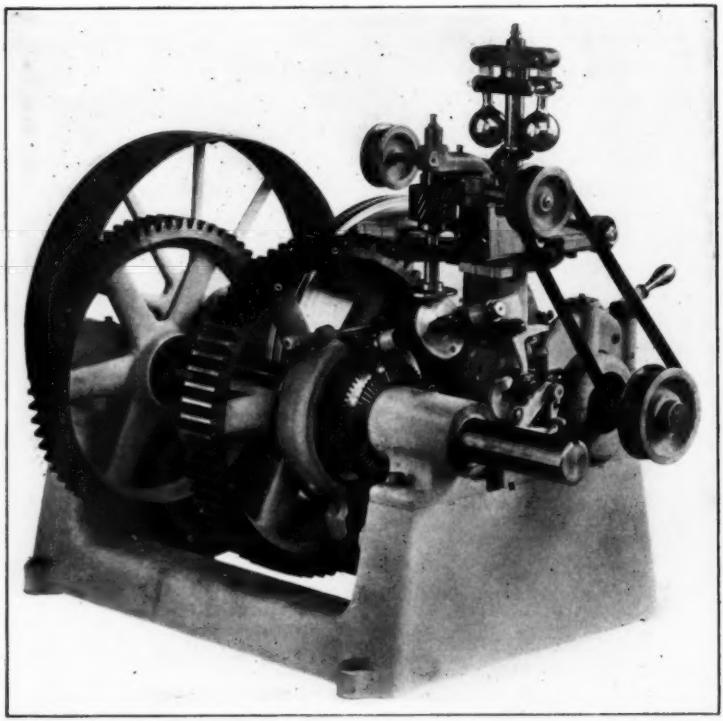


PELTON WATER WHEEL.

vey should extend throughout a year, carefully recording the measurements relating to volume of water available during the dry season. Drainage area and average waterfall are not sufficient data; the actual minimum flow during the dry season determines the safe size of power plant for every day service throughout the year. Any drainage area having extreme low water during the dry season is certain to have periods of excessively high water following the winter months and the rainy seasons of the summer months. A stoppage of a water power plant by reason of flooding may be fatal to the commercial side of the undertaking, even though the stoppage occur but a day or two at a time, and for but two or three times in a year. This would be analogous to the stopping of a street railway system, or the extinction of electric lights in a City for three or four days. It would so depreciate the value of the securities based upon such a plant as to make investment undesirable except at a ruinous discount from face values. In such a case there is no other alternative than to duplicate the plant with either steam or gas engines which, remaining idle throughout the greater part of the year, would result in financial loss; so that from a competitive standpoint, any proposed water power, among other advantages over steam power, must have the assurance of constant supply. The problem finally resolves itself into Water vs. Coal.

Reciprocating steam engines of the best design and construction will, at 160 pounds pressure, in large units, develop an indicated horsepower per hour for each fifteen pounds of water evaporated, the steam being delivered to the engine at not less than 160 pounds pressure. It is admitted that lower figures have been published by competent experts—Thurston, Barrus, Dean and others. The lowest record up to the year 1900 was 12.5 pounds of steam per I.H.P. per hour with a boiler pressure of 155 pounds and without superheating. But the highest efficiency reached in this country is that of the triple expansion pumping engine at Chestnut Hill, Boston, with a record breaking performance of 10.335 pounds and a thermal efficiency of 21.63 per cent. Professor Ewing in *Engineer, London,* states that in a certain test made by him, the consumption of steam was just 9 pounds per I.H.P. when the engine was working at the most favorable load. The steam pressure was 140 pounds, with 800 degrees superheat. No such record has been made in this country. For our present purpose 15 pounds may be considered to be good practice in steam engineering for the best types of reciprocating engines.

Steam turbines, in this country at least, have shown no thermal advantage over the best types of reciprocating engines, the Parsons,



HORIZONTAL MODEL COMPENSATING TYPE GOVERNOR. THE WOODWARD GOVERNOR CO., ROCKFORD, ILL., U. S. A.

Type B. is adapted to units up to 3,000 h. p.; type F. up to 1,200 h. p. Among the numerous important installations of this governor, is that at tne U. S. Arsenal, Rock Island, Ill. The capacity of a governor is principally limited by the power required to operate the gates.

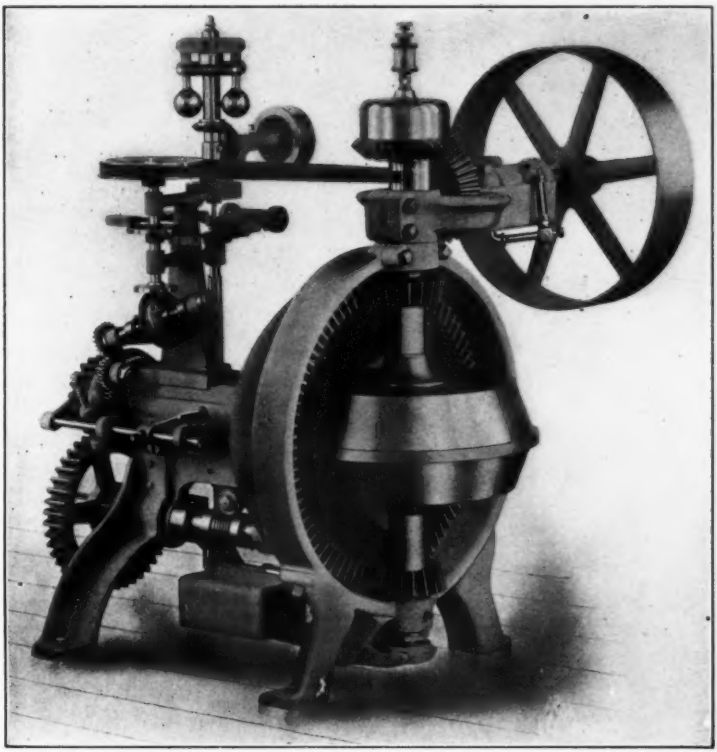
De Laval and Curtis turbines averaging about 15 pounds of steam per I.H.P. per hour.

A large annual rainfall together with an enormous drainage area throughout the United States has made possible the profitable development of thousands of water power plants. The possibilities of electrical transmission of energy has transformed many a mountain stream hitherto of no commercial value into a source of profit.

A cubic foot of water weighs about 62.36 pounds; the horse power for any given volume and head would approximate cubic feet of water flow per second x 62.36 x head of water in feet -:- 550. There

will, in practise, be an aggregate loss from various causes of from 20 to 40 per cent. of the total, say 25 per cent., by way of average.

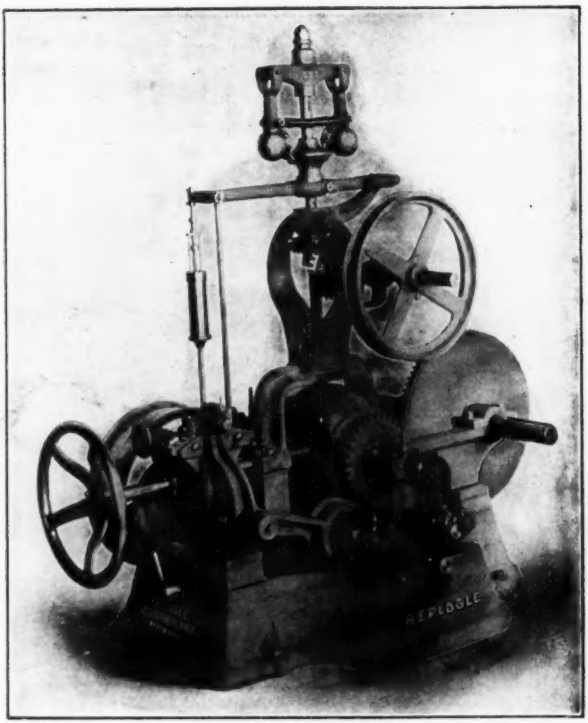
The selection of a water wheel resolves itself practically to choice between a turbine, if for low or medium heads, and an impulse wheel for high heads. Ordinary turbines work well under moderate heads, say 10 to 20 feet. The next thing is to design the head and tail races. If the wheel is to be supplied by an open canal or headrace, the latter must have an area of cross section such that the flow of water to the wheel shall not exceed 60 feet per minute for a long headrace, increasing to 120 feet per minute for a short one. If the headrace is insufficient in area of cross section in proportion to its length, there will



VERTICAL MODEL COMPENSATING TYPE GOVERNOR. THE WOODWARD GOVERNOR CO., ROCKFORD, ILL.

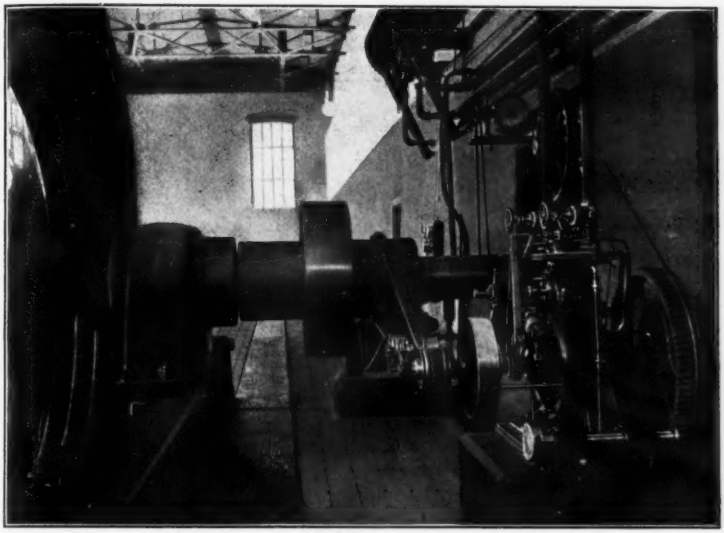
Type C. is used mostly on wheels up to 600 h. p.; type D. up to 300 h. p. A large number of these governors are installed in the U. S. and in Europe.

be a gradual loss of head which results in loss of power. The tail-race should have an area of cross section such that no greater velocity of flow than 100 feet per minute will occur; and there should be not less than two feet of dead water at the point of discharge for small wheels. This depth may, with advantage, be increased to four or five feet in the case of large wheels. Such depth of water occasions



REPLOGLE GOVERNOR NO. 3.
Designed for large turbines or multiple units of medium sized turbines. 7,500 foot-pounds capacity. Replogle Governor Works, Akron, Ohio, U. S. A.

no loss; the water discharged from the wheel displaces the dead water with practically slight loss of head. The rule that for any diameter of wheel under any head, there should be one square foot of cross sectional area of head-race and of tail-race for every 120 cubic feet of water used per minute, should be rigidly observed, as when the head is reduced from any cause, there may still be sufficient flow to run the wheel up to speed and capacity.



WATER WHEEL GOVERNOR.
Sturgess Governor Engineering Company, Watervliet, N. Y., U. S. A.

When the water is conveyed to the wheel casing by a metal pipe, the receiving end should be well submerged to prevent the inlet water from drawing in air, and lessening the efficiency of the wheel. An increased velocity of flow is permissible, which should not, however, exceed 180 feet per minute for pipes up to 150 feet in length, reducing the velocity to 100 feet per minute in pipes 250 feet long. No loss of head is likely to occur at these velocities in a pipe free from sharp angles.

Draft tubes can be used in connection with turbine wheels in favorable locations; such tubes should extend vertically downward and should not greatly exceed 20 feet in length. They should in all cases be made of plate metal, strongly riveted and caulked air tight. One of the writer's earlier experiences was with a 48-inch draft tube extending down a slope about 300 feet in length, the fall being about 23 feet; it was simply impossible to maintain a constant speed of wheel until an air pump was set in the wheel house, by which the draft tube was kept free from air, and even then the speed and power were not wholly satisfactory.

Loss of head occurs in conveying water through pipes, thus: for each 100 feet in length, of a pipe, say, 48 inches in diameter, the water

flowing at velocity of 2 feet per second, the loss in head would be 0.024 foot; at 4 feet per second, 0.093 foot; at 6 feet per second, 0.204 foot. In a 24 inch pipe increased resistance would cause nearly three times as much loss in head.

A sudden interruption of flow to a wheel is always to be guarded against, especially in the case of a closed penstock or a long pipe leading to the wheel casing. To remedy this, a stand-pipe may be used from the top of the penstock for heads under 50 feet, or a relief valve for similar or greater heads.

Combined steam and hydraulic power plants are to be occasionally found. A good installation is that at Richmond, Va., the total available fall being twenty-five feet. Double turbines of the horizontal type are situated in submerged chambers beneath the boiler room, and from the wheels concrete draft tubes extend to the tail race below. There is a complete steam auxiliary. Each turbine shaft couples at one end directly to the generator shaft; at the other end of the generator shaft is the engine crank. When it is desired to shift from water power to steam, the turbine coupling has its bolts removed, the connecting rod is attached to the crank pin and the generating plant is ready for use. It is the intention to have eleven water turbine and steam engine units of 1,000 H. P. each, upon the completion of the plant.

Turbines receive and discharge water uniformly, and usually in each bucket simultaneously. The buckets are usually curved, and the water is guided by adjustable plates into the buckets of the revolving wheel. The delivery of water to the wheel is controlled by a series of swinging valves, which may be adjusted by hand or placed under the control of a governor. The wheel is driven partly by the weight of the descending water and partly by the impulse of the flow, hence turbines may be classed as pressure or reaction turbines, or as impulse turbines. In pressure or reaction turbines, the wheel passages are filled, the energy is largely due to pressure, and the discharge is below tail water, or in a draft tube. In turbines of this class, the flow of water may be parallel or axial as in the Jonval; outward as in the Fourneyron; inward as in the Swain, Thomson and others; mixed, i. e., inward and parallel, as in the Schiele.

The Jonval turbine is a pressure turbine, consisting of a series of guide blades arranged in a ring directly above the buckets of the revolving wheel; the flow of water is downward and parallel to the axis of the wheel. This form of turbine is always drowned, or connected to a draft tube surrounding the wheel, thereby adding the

suction head of the discharge to the head above the wheel. The tube should not exceed 25 feet in height. Regulation, formerly effected by throttling, is now preferably obtained by closing a number of guide passages, preserving free admission for those uncovered. The Bodine-Jonval turbine is of this class. The wheel is adjustable to the case so as to prevent loss of water by leakage. This wheel runs steadily and evenly, and reasonably free from leakage. The maximum efficiency, from tests made at Lowell, was, with full gate, 75.9 per cent; three-fourths gate, 72 per cent; with half gate, 61.3 per cent.

The Girard Turbine provides against the loss of efficiency which always occurs when pressure turbines work with fractional supply, this fault being due to the attempted driving with a pressure for which they were not designed. Girard widened his wheel passages towards the outlet, and ventilated them so as never to entirely fill them with water. The energy is purely due to velocity, and the turbine is an impulse machine; it has also a parallel flow and complete admission to whatever guide passages are open.

Outward flow turbines.—The Fourneyron turbine receives water near the axis and delivers it outward at all points of the circumference, into buckets or curved blades of the wheel, which change the flow to a radial direction, the water leaving with little absolute tangential velocity. When the supply of water is insufficient for full power, the openings in the central chamber are partially closed by a cylindrical valve which is lowered as may be required, reducing the efficiency of the wheel which, at best, ranges between 70 and 80 per cent.

The Boyden Turbine is constructed on the same principle, but differs in important particulars. The water is conducted to the wheel through a vertical truncated cone concentric with the shaft, the descending water gradually acquiring velocity with a spiral movement in the direction of motion of the wheel. The guide plates at the base are inclined to meet tangentially the approaching water. A "diffuse" or annular chamber surrounds the wheel, into which the water is discharged. The efficiency is about that of the Fourneyron.

Inward flow Turbines.—The Swain wheel was probably the first of this type. These wheels are surrounded by annular cases in which guide passages direct the water inward to the buckets. Mr. Swain introduced a double curve in the form of the inwardly discharging bucket, so that the discharge is downward instead of inward; the long double curve of the bucket retains the water until it has re-

ceived a very large percentage of its initial power. For a bronze wheel having twenty-five buckets, the gate had twenty-four guides set to form an angle of fourteen degrees, with the tangent to the wheel passing through their inner edges. According to tests made at Lowell, the efficiency, from about two-thirds to full gate, varied from 83 to 84 per cent.

Following the type of Swain turbine came a number of well known wheels, as the Risdon, The American, Alcott, Leffel and others.

Thomson's turbine receives its water supply at the outer rim of the wheel, the water escaping axially from the center of the wheel into the tail-race. Its energy is largely due to pressure, the outlet being either drowned or connected with a draft tube. The guide blades are pivoted and so curved that the water supply can be regulated without materially affecting the angle of the blades or other conditions. A maximum efficiency of about 75% is obtained for all openings.

Turbines attached to vertical shafts are more used than those of the horizontal pattern. Vertical turbines as ordinarily constructed and operating under heads of 25 feet and over are likely to be troublesome on account of difficulty in properly lubricating the step bearing and in replacing a worn out one. This bearing has to take the weight of the upright shaft and gearing in addition to its own weight, and in many cases, an added pressure due to the impact of the water upon the blades. To relieve the step of this weight, a water cushion operating with little or no friction has been satisfactorily employed as in the Trump turbine. The upward pressure of the water is augmented by the lessened pressure occasioned by a pipe connection leading from the chamber above the running balance plate, downward and into the inlet to the central runner. Hard wood bearings prevent metal contact between the balance plate and the stationary portions of the frame. For low heads about three-fourths of the weight is thus relieved; for high heads, the whole weight can be carried without the use of a step bearing. Direct connected generators placed at the top of a vertical turbine shaft are in use in this country, notably at Niagara Falls, as well as on the continent of Europe. This arrangement has been found to be cheap and efficient. The Niagara Falls Power Company, among other turbines, adopted a design of the Francis Turbine by Escher Wyss & Co., Zurich, wherein the balancing disc for the turbine (5.25 feet diameter) weighs 4,000 pounds; the revolving armature, weighing 69 tons addi-

tional, was 4.9 feet diameter; the upward pressure being so regulated that only about 5 tons of the total weight is carried by an outside bearing.

Vertical turbine shafts may be connected by bevel gearing to a horizontal shaft, a method commonly applied to installations having abundance of water with comparatively low head. The loss in power transmission by the use of bevel wheels will approximate 10 to 20 per cent. of the total power of the turbine.

Tandem wheels are not in common use, but such an application is well illustrated in the installation at Geneva, where the engineers found themselves confronted with a difficult problem, because of the great difference in height of water at various seasons, the variation being from 14 feet to 29 feet. As the turbine shafts were vertical with generator directly above, and a constant speed of rotation was imperative, the problem was solved by building a two story water station, and placing two turbines, one above the other below, on each generator shaft. The plant had 18 sets of turbines, 15 of which were of 1,000 horse power each.

Horizontal turbines are in very general use, and, while less efficient than vertical, bevel gearing with attendant loss by friction is avoided, to say nothing of costly repairs. They occupy more floor space than vertical ones and their first cost is greater. The elbow or other conduit for carrying the water from the wheel to the tail-race should be slightly larger than a straight draft tube under a vertical wheel. In mill practice, power transmission from a turbine is usually to a horizontal shaft. With a horizontal turbine the coupling may be directly at the end of the wheel shaft and transmission secured by an extended shaft, by belt or rope transmission from pulley, or coupling direct to a generator. Two horizontal turbines are commonly arranged on the same shaft, and connected in multiples of two, three or more pairs, each wheel commonly having its own draft tube, the water inlet being in a casing common to two wheels, the discharge being into a quarter turn elbow at each end of the horizontal casing or flume. The end thrust of the wheels is thus equalized and the pressure equally distributed throughout the flume. For single horizontal wheels, a water cushion may be employed as in vertical installations.

High speed turbines are had by reducing the diameter of the wheel. Turbines of the same diameter run at practically the same speed. The speed of rotation cannot be increased by merely changing the curve of bucket without a loss of efficiency; to overcome this

loss turbines may be placed in tandem, but this is not recommended for regular service.

Impulse wheels are best suited to high heads, 200 feet and over. In turbines of this type the wheel passages are never filled, the energy being entirely due to the velocity of the discharged water from the nozzle directed against a series of buckets arranged at regular intervals on the periphery of a metal disc. The energy of the stream is absorbed by the buckets and transmitted to the shaft, the spent water falling from the buckets at no working velocity. The end of the pipe leading water to the wheel is fitted with a nozzle in the end of which is a cylindrical tip of a diameter proportioned to the head of water and the power to be developed by the wheel. The power of a wheel of this type does not depend upon its diameter, but upon the head and quantity of water discharging into the buckets. The speed of the wheel for a given head is determined by its diameter, and this speed should be constant irrespective of the power to be developed. An increase of power for a given speed of rotation can be had in the case of a small wheel by the addition of another set of buckets on the same disc with another nozzle; the power and also the quantity of water used can thus be doubled. A wheel of sufficient diameter may have two nozzles arranged to discharge into one set of buckets, the nozzles being so located that the spent water from the first discharge will not interfere with the second. Double buckets and twin nozzles are also used for the same end.

Tangential or impulse water wheels require no wheel casings, no regulating gates or vanes and no draft tubes. The conditions under which such wheels usually work require the transmission of water through long pipe lines terminating in high pressures. A satisfactory, but not unusual, installation, is the American River Electric Company's plant in Central California which has two pressure pipes 1,614 feet long and 36 inches diameter. The upper portion, which is made of red wood staves, passes over one easy grade for a distance of 400 feet, at which point the pressure is about 60 pounds per square inch. Connecting at this point is a riveted sheet steel pipe, the thickness increasing with the head; the first 400 feet is of No. 10 steel, then 150 feet of 3-16 inch, 150 feet of ¼ inch, 150 feet of ⅜ inch and 364 feet of 7-16 inch, making a total of 1,214 feet of steel pipe, a static head of 575 feet being obtained. The water wheels are constructed of cast steel plates fitted with Pelton buckets. The two impulse wheels have a maximum capacity of 3,000 horse power each. The generating plant is located

about 90 miles east of Sacramento, supplying power over an 80 mile circuit to Stockton, and over a 30 mile line to Folsom, the present voltage being 35,000, but the line is built to carry 60,000 volts. A remarkable installation utilizing a head of 2,150 feet, equivalent to 935 pounds per square inch, is that of the Pike's Peak Hydro-Electric Co. of Colorado Springs, Col. There are three impulse wheels, each connected to a 750 kilowatt electric generator running at 450 revolutions per minute.

Water wheel governors are constructed with revolving weights hung on pivoted joints similar to steam engine shaft governors. At normal speed the weights are midway in the two extremes of innermost and outermost positions. Should a change of load occur the speed of the wheel will be lessened, occasioning a change in the rate of revolution of the governor; the weights will approach the center and, through proper connections, admit more water to the wheel, thereby increasing its speed, which is likely to go above the normal. The effect of this will be to cause the weights to fly further from the center, and this movement will affect a closing of the water gate and a lowering of the speed of the wheel. If this variation can be kept within 2 per cent. it is considered good governing.

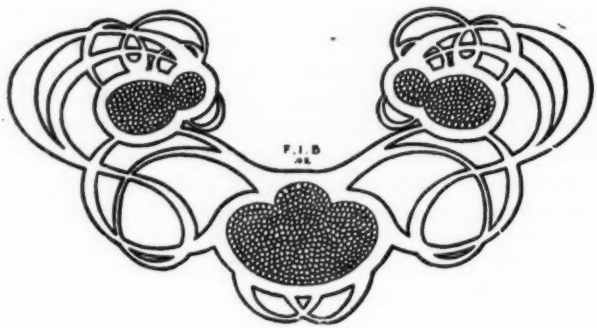
The power required to operate a turbine gate is more or less uncertain, the wheel often being designed with reference to high efficiency, leaving the matter of adjustment and automatic regulation for after consideration. Through the coöperation of turbine and governor manufacturers, controlling devices are now applied by which turbines are run with a precision equal to that of steam engines. The power required to move the water gate in time to keep speed within allowable limits of variation must be supplied through the governor itself, and, in selecting a governor, this detail must have proper attention. The time limit from full open to shut will vary from 10 to 30 seconds for loads varying as much as 25 per cent. of the normal. Surplus capacity of wheel is essential to good governing. Wheels should always have an overload capacity of at least 25 per cent.

In the case of a Pelton wheel, speed is controlled by means of a cast iron deflecting nozzle provided with a ball and socket joint, permitting of its being raised or lowered, thus throwing the stream on or off the buckets. The power of the wheel is consequently increased or diminished to adapt to change of load, and a constant speed is maintained. The stream cut-off is a spherical plate fitting tightly over the end of the nozzle tip which, by varying its position, changes the discharge area of the nozzle, and thus influences the

power of the wheel. The needle and deflecting nozzle is a most valuable combination. This accomplishes a two-fold object—accurate regulation and water economy without water ram. The deflecting nozzle in itself is a most sensitive means of regulation when actuated by an automatic governor, but does not save water. On the other hand, the needle nozzle, while it is extremely economical in the use of water, is difficult to control quickly by means of the governor.

The total available water power of the rivers and streams of the United States has been estimated at two hundred millions horse power, of which only about four millions are now in use. With long distance electrical power transmission, much of this can be brought into immediate utilization. It thus becomes possible, with a proper extension of Hydro-Electric power systems throughout the country to introduce important factors in the industrial world which are now comparatively barren of results.

The extent of the development of this enormous power is beyond prediction by any one now living. The present generation will, however, witness a very great progress. It seems almost that this great natural resource, has been created to meet the unprecedented growth of the population of the United States, whose industrial wants have multiplied at a rate much transcending the rate of its increase. The reign of steam power has been most brilliant; but water power existed and was largely utilized before Watt founded the steam dynasty. I think since it has secured as its ally the inexhaustible resources of electricity its future may yet rival that of steam in its supply of mechanical power.



WORKING EXAMPLES OF SUCCESSFUL STORES MANAGEMENT.

THE SYSTEM AND METHODS OF THE B. F. STURTEVANT COMPANY.

By Walter B. Snow.

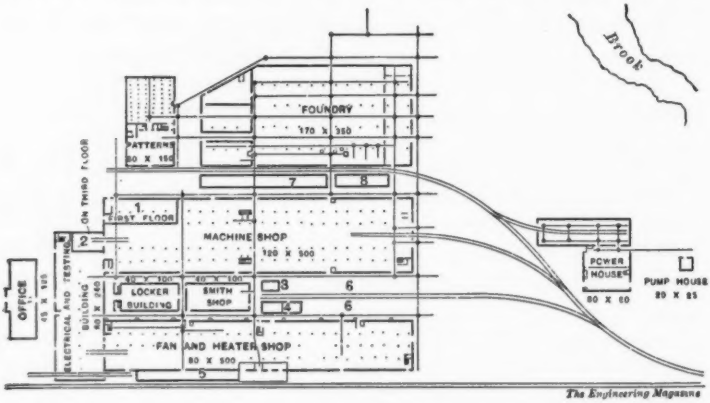
THE buildings of the new plant of the B. F. Sturtevant Co., at Readville, in the town of Hyde Park, Mass., cover a ground area of about five acres; their aggregate floor area exceeds nine acres. They are located beside the freight yards of the N. Y., N. H. & H. R. R., and are arranged in parallel, with five spur tracks, entering or running between the buildings at convenient points. All tracks may be used for receiving merchandise, but those extending into the buildings are usually employed for the shipment of finished products which may be loaded upon the cars by means of traveling cranes.

The great diversity in the character of the products, and of the methods and materials utilized in their production, naturally compels a distinct separation of all departments and, to a lesser extent, of the stores required therein. The general arrangement of stores rooms and storage locations is shown by the accompanying plan. Ordinary supplies of scrap, coke, sand, furnace coal and the like are stored in bins close beside and parallel to the foundry, but separated from it by the steam railroad track from which they are readily unloaded. Pig iron is stored out of doors; each carload being marked with its consecutive analysis number. Steam coal is carried in an open pocket with concrete bottom.

The main stores room in the machine shop serves all departments with general supplies and with standard articles such as bolts, nuts and rivets. A portion of this room is devoted to the storage of the smaller finished parts of engines. In the center craneway of the machine shop completed engine frames are symmetrically piled, while crank shafts are supported upon racks served by an overhead jib crane. The special storeroom in the Electrical Department is there located for convenience of access and only contains articles used exclusively in this department.

In the yard between the machine and fan shops, and adjacent to the forge shop, are stored under lock and key all of the round and flat bar iron, tool steel and the like required in the forge shop. This shed, as well as the piling floor and the racks for angle iron, is located close beside the spur track so that unloading requires the least expenditure of labor. Temporary supplies of bolts, nuts, rivets and the like required only in fan production are maintained at the most accessible points within the fan building. These supplies are periodically replenished from the general stores room.

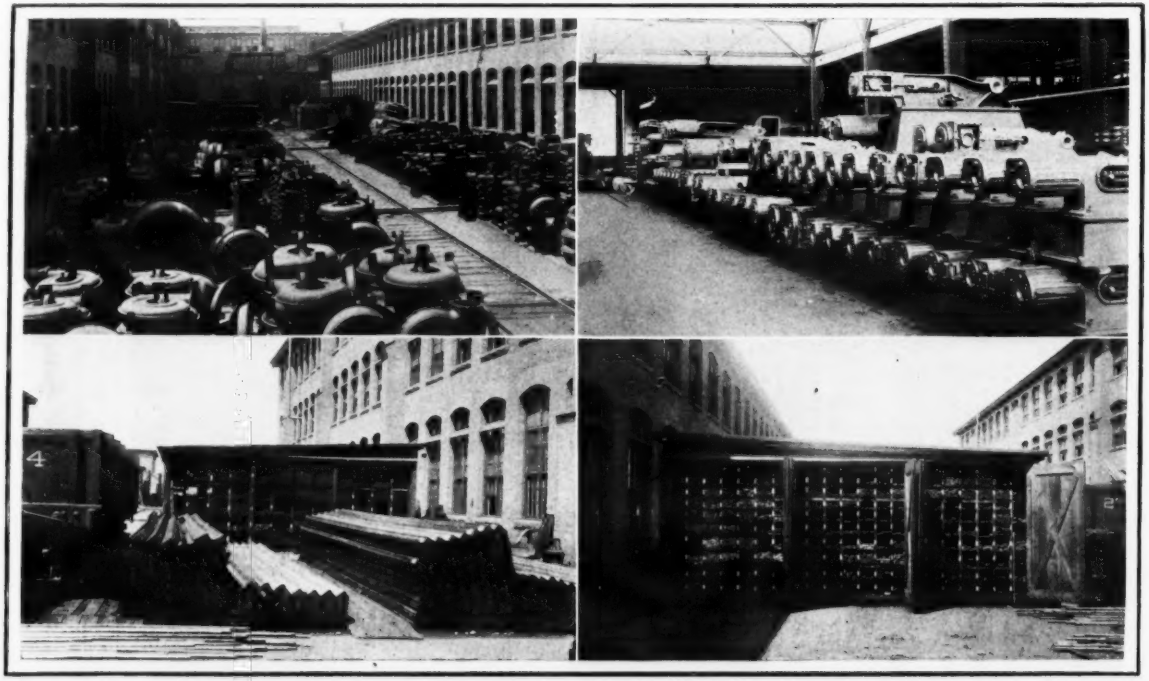
Black iron sheets, of which large quantities and varieties are used, are discharged directly from the cars into the storage building, whence they are drawn as required for working up in the adjoining fan build-



GENERAL PLAN OF WORKS OF THE B. F. STURTEVANT COMPANY, HYDE PARK, MASS., U. S. A.

ing. They are stacked on edge in compartments arranged diagonally to the main aisle of the building. So far as possible castings from the foundry are delivered and stored near the points where they will pass through the first machining process.

All orders for materials issued by the Purchasing Department are based upon formal requisitions from the heads of departments of the form indicated by F 377. The respective requisition numbers appear upon all orders, and shippers are requested to place same on all packages. In certain departments, such as the Plate and Pipe Dept., a weekly inventory of all sheets in stock is taken upon blanks like F 527; the same form being utilized as a part of requisitions and purchase orders.

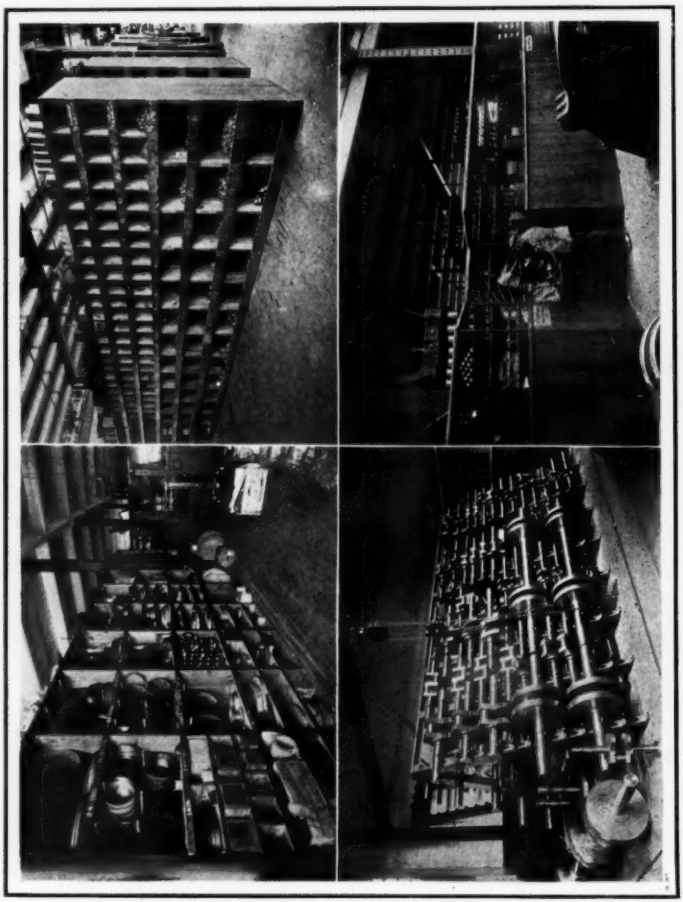


STORES OF B. F. STURTEVANT COMPANY.

Storage of Castings in Yard.
Storage Floor for Angle Iron and Racks for Small Angles and Large Round Stock.

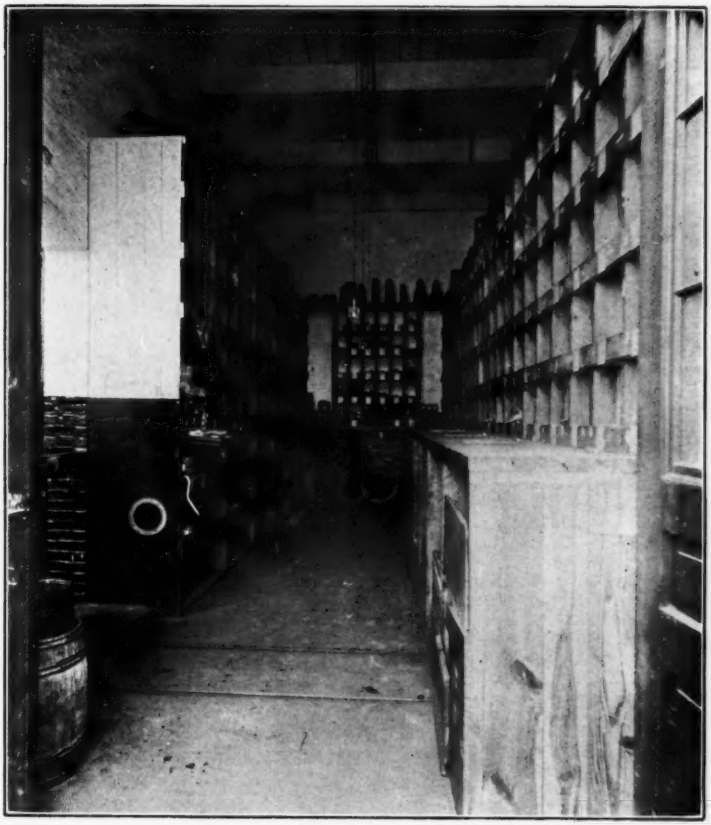
Horizontal Engines Stored in Machine Shop.
Storage Racks for Flat and Rround Irons.

Two manifolds are made of each order on form F 448. One is filed in a consecutive loose leaf binder and the other, minus the price, which is omitted in manifolding, is furnished to the stores keeper. The receipt of goods with weight or number of pieces is noted in a blotter



STORAGE ROOMS, B. F. STURTEVANT COMPANY.
Upper Left—Stores Room, Electrical Department. Upper Right—Stores Room, Machine Shop. Lower Left—Storage for Crank Shafts. Lower Right—Delivery Gate, Machine Shop Stores Room.

by him, and notation thereof made upon his copy of the purchase order. If said notation indicates that order is filled it is at once returned to the Purchasing Department, and a transcript made in the loose leaf binder file. Form F 541 printed upon the back of each mani-



STORE ROOM FOR VALUABLE METALS AND BRASS CASTINGS IN CONNECTION WITH MACHINE SHOP STORES ROOM.

fold order serves as a place of record regarding the succeeding order which faces it in the book. If only a portion of the order is received, note of the same is made in manifold by the stores keeper. One copy is sent to the Purchasing Department and the other attached to his copy of the order. When the order is completed the stores room copy of the same with attached manifold, or manifolds, is returned to the Purchasing Department. Freight bills are receipted by the stores keeper. The order number to which the same, as well as other transportation, is chargeable is noted thereon, and the amount recorded upon the copy of order.

REQUISITION FOR MATERIAL

B. F. STURTEVANT CO.
JAMAICA PLAIN, MASS

REQ. NO. 500

DATE .....

To the Purchasing Agent:

Please supply this Department with

Prod. Order .....

Shipping Order .....

..... DEPT

Per .....

FORM F-448.
Actual size, 5" x 8".

ORDER FOR MATERIAL.

B. F. STURTEVANT CO.
Post Office and Telegraph Address.
HYDE PARK, MASS.

FREIGHT AND EXPRESS ADDRESS
READVILLE, MASS.

MARK EACH PACKAGE WITH THESE NUMBERS { PURCHASE ORDER NO. / REQUISITION NO. / SALES ORDER NO.

To

STANDING ORDER NO.

Please furnish the following:

SHIP VIA

WANTED

TO B. F STURTEVANT CO.
READVILLE, MASS.

Render invoice promptly and indicate the order number thereon.
When goods are purchased F. O. B. destination, transportation charges MUST IN ALL CASES BE PREPAID.
Bill of Lading should accompany invoice.

B. F STURTEVANT CO.

Per

FORM F-377.
Actual size, 8" x 10".

STANDING ORDER NUMBERS FOR LABOR AND SUPPLIES

PRODUCTION DEPARTMENT — **B.F. STURTEVANT CO.** — NOV. 7, 04

	Pro-ductive or Direct	Non-Productive or Indirect											
		Not Otherwise Classified	Handling Care General	Super-vision	Small Tools	Mach. Tool Repairs	Equip. & Repairs thereto	Store-keeping	Supplies				
Production Dept. Office		1							8				
Drafting Dept.									18				
General		11 A											
Engine		11 B											
Electrical		11 C											
Blue Printing		11 D											
Engine. Erecting & Testing Dept.	21		22	23	24	25	93		28				
Outside Erection, exclusive of 61 X.	31				34		36		38				
Electrical Dept.	41		42	43	44	45	46	47	48				
Fan Dept.			62	63	64	65	66		68				
Large S.P.Fans & Heater Jackets	61 A												
Small S.P.Fans	61 B												
Heater Sections	61 C												
Pulleys & Forges	61 D												
Fan Testing	61 E												
Large C.I.Fans	61 F												
Small C.I.Fans	61 G												
Blower Shafts	61 H												
Blower Boxes	61 J												
Planing	61 K												
Blast Wheels	61 L												
Galv. Iron	61 M			63 M									
Galv. Iron, outside work	61 N												
Repairs	61 P			63 P									
Machine Dept.	81		82	83	84	85	86	87	88				
Economizer Dept.	101		102	103	104	105	106		108				

The Engineering Magazine

FORM T-3753.

Actual width, 9½". Only part of the list shown.

B. F. STURTEVANT CO., BOSTON, U.S.A.

PLATE LIST ..... 19 .....

PLATE AND PIPE DEPT.

REQ. NO. .....

ORDER NO. .....

Location	Gauge	SIZE	QUALITY	Weight per Sheet	Maximum Stock	On Hand	To be ordered	Total Weight	REMARKS
A	11	54½ x 96	B. A. Pat. L.	181.7	150				
A	"	50½ x 96	" "	168.4	"				
A	"	48½ x 96	" "	161.7	"				
A	"	61 x 68	" "	144.	"				
A	"	50½ x 84	" "	147.3	"				
A	11	54½ x 84	B. A. Pat. L.	160.	150				
A	"	60½ x 84	" "	176.5	"				
A	"	64½ x 84	" "	188.2	"				
A	"	64½ x 120	" "	268.8	"				
A	"	60½ x 120	" "	252.1	"				
A	11	54½ x 120	B. A. Pat. L.	227.1	150				
A	"	50½ x 120	" "	210.4	"				
A	"	48½ x 120	" "	202.1	"				
A	"	64½ x 96	" "	215.	"				
A	"	60½ x 96	" "	201.7	"				
B	3-16	48½ x 78½	Soft Tank Steel	198.	50				
B	"	38½ x 96	" "	192.	"				
B	"	40½ x 96	" "	202.5	"				
B	"	42½ x 96	" "	212.5	"				
B	"	44 x 88	" "	203.	"				
B	3-16	48½ x 88	Soft Tank Steel	222.5	50				
B	"	38½ x 84	" "	168.5	"				
B	"	40½ x 84	" "	177.2	"				
B	"	42½ x 84	" "	186.	"				
B	"	44½ x 84	" "	194.7	"				
B	3-16	46½ x 84	Soft Tank Steel	203.5	50				
B	"	48½ x 84	" "	212.2	"				
B	"	50½ x 84	" "	221.	"				
B	"	54½ x 84	" "	238.6	"				
B	"	60½ x 84	" "	264.7	"				
B	3-16	64½ x 84	Soft Tank Steel	282.2	50				
B	"	28½ x 120	" "	238.	"				
B	"	64½ x 120	" "	403.2	"				
B	"	60½ x 120	" "	378.2	"				
B	"	54½ x 120	" "	340.7	"				
B	3-16	50½ x 120	Soft Tank Steel	315.7	50				
B	"	48½ x 120	" "	303.2	"				
B	"	46½ x 120	" "	290.7	"				
B	"	44½ x 120	" "	278.2	"				
B	"	42½ x 120	" "	265.7	"				
B	3-16	40½ x 120	Soft Tank Steel	253.2	50				
B	"	38½ x 120	" "	240.7	"				
B	"	64½ x 96	" "	322.5	"				
B	"	60½ x 96	" "	302.5	"				
B	"	54½ x 96	" "	272.5	"				
B	3-16	50½ x 96	Soft Tank Steel	252.5	50				
B	"	48½ x 96	" "	242.5	"				
B	"	46½ x 96	" "	232.5	"				
B	"	44½ x 96	" "	222.5	"				
B	"	61 x 68	" "	216.0	"				
				TOTAL					

FORM F-527.
Actual size, 7½" × 9⅛".

The principal stores room which occupies one corner of the machine shop, adjacent to the erecting shop and testing plates, measures 40 ft. x 120 ft., and is 17 ft. high. Wooden bins are provided for the storage of small pieces in quantity. Articles from which temporary supplies are elsewhere maintained are kept in the original packages.

Finished parts are carried upon shelves which are supported upon cast iron brackets clamped around pipe columns extending from floor to ceiling. Metals, other than iron, small forgings, brass, steel, malleable iron and similar castings, are stored in suitable bins. All castings and forgings are designated by pattern or piece numbers. Castings received from the brass foundry are listed on a special form which

6 x 6 V.S. 5. AUTOMATIC ENGINE. R.A.J.

B. F STURTEVANT CO., HYDE PARK, MASS. MARCH 18 1905

PRODUCTION LIST T-4057 A

T-4057.

ERECTION DRAWING 6-2308 / NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.	NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.
BED	6-2307	22813	1.	C. I.	STUDS (TO FRAME)	6-2292	3/4"	6.	STEEL
HAND HOLE COVER	T-3954	23630	2.	"	NUTS.	"	3/4" HEX.	6.	W. I.
CAP SCREW.	"		4.	STEEL	DOWELS.	"	1/2"	2.	STEEL
					HEAD. (TOP.)	6-2277	22728.	1.	C. I.
					COVER.	"	1/16" THICK	1.	SHEET STEEL
CONNECTING ROD.	6-2276	R. 22578	1.	STEEL	MACHINE SCREW.	"	3/16"	4.	STEEL
CRANK BOX (OUTSIDE)	"	XX22579	1.	MALL IRON	STUDS.	"	5/8" x 2 1/2	6	"
" " INSIDE.	"	XX22618	1.	"	NUTS.	"	5/8" HEX.	6.	W. I.
BOLTS	"	R. 22621	2.	STEEL	JACK. BOLTS.	"	1/2" x 1 1/2	2	STEEL
WRIST BOX (OUTSIDE)	"	022620	1.	COMP.					
" " INSIDE.	"	022619	1.	"					
BOLTS.	"	R. 22622	2	STEEL					
NUTS.	"	3/4" HEX.	8	W. I.	DOORS.	6-2300			
SPLIT PIN	"	3/32"	4.	STEEL	SIDE DOOR (TOP.)	"	22791.	2.	C. I.
					" " BOTTOM.	"	22792.	2.	"
					FRONT. "	"	22793.	2.	"
CRANK	6-2293		1.	STEEL	CAP SCREW.	"	3/8"	34	STEEL
C.I. COUNTER WEIGHTS.	"	22766	2.	C. I.	KNOB.	"	R. 1520	4.	"
BOLTS.	"	9/16"	2.	STEEL	NUTS.	"	3/8"	4.	W. I.
NUTS.	"	1/2" HEX.	4.	W. I.	OIL DEFLECTOR.	"	22796	2.	C. I.
SPLIT PIN.	"		4.	STEEL	SCREW.	"	3/16" x 7/16	4.	STEEL
PLUGS.	"	3/4" PIPE	6.	C. I.					
"	"	3/8" "	2.	"					
COLLAR. (C. I.)	6-2300	22795	1.	"	DRIP CONNECTIONS. BODY	T-3978	022859	2	COMP.
					BUSH OF VALVE.	"	013111	2.	COMP.
					VALVE STEM.	"	022858	2.	"
CROSSHEAD	6-2294	22769	1.	C. I.	HAND WHEEL.	"	22378	2.	C. I.
GIBS.	"	22700	2.	"	GLAND.	"	022861	2	COMP.
ADJUSTING SCREW	"		2.	STEEL					
NUTS.	"	1/2" HEX.	2	W. I.	ECC PIN. SEE REGULATOR PROD LIST T-3954				
WRIST PIN.	"	R. 22771	1.	STEEL					
NUT.	"	1 1/2" HEX.	1.	W. I.					
SPLIT PIN.	"	1/8"	1.	STEEL	ECCENTRIC ROD.	6-2297	XX22779	1.	MALL IRON
					CAP (TOP).	"	XX22780	1.	"
					" (BOTTOM).	"	XX22327	1.	"
CYLINDER.	6-2292	22763	1.	C. I.	STUDS.	"	7/8"	4.	STEEL
LAGGING	"	RUSSIA IRON			NUTS.	"	7/8" HEX.	8.	W. I.
MACHINE SCREW.	"			STEEL	SPLIT PIN.	"	5/32"	4.	STEEL

T-4057

FORM T-4057.
Actual size, 8½" x 11".

F541-10M-4-1-05

ORDER NO. _____

ORDER ACKNOWLEDGED _____ PROMISED _____

WROTE THEM		
TO TRACE	TO HURRY	REPLY

BILLS			RECEIPTS	
DATE	APP.	ITEMS	DATE	ITEMS

COMPLETED

FORM F-541.
Current Order Record. Actual size, 8″ x 10″.

is made and receipted in manifold. One copy is retained in the stores room and the other is passed to the Production Department.

Material delivered from the stores room is receipted for upon Productive or Non-Productive Material Cards, (F 472 printed on white, and F 473 printed on pink paper) according to the character of the material. Productive material is classed as that which forms a

F 472

PRODUCTIVE MATERIAL CARD

Use this card for Material on Shipping and Production Orders only
Do not use it for Material on Standing Order

DATE _____ 190____

RECEIVED FROM _____ DEPT.
Write here name of dept. delivering article

FOR _____ DEPT. TO BE USED ON ORDER NO. _____
Write here name of dept. receiving article

QUANTITY	ARTICLE	WEIGHT	PRICE	AMOUNT

TO BE USED FOR _____
Explain here purpose for which article is required

Sign here only upon receipt of article FOREMAN

The Engineering Magazine

FORM F-472.

Printed on white paper. Actual size, 4" x 6".

ENGINE ASSEMBLY REQUISITION

ORDER NO. _____

DELIVER TO ENG. ERECTIEG DEPT. _____ No. of Eng's _____ Size and Type | R.H. | L.H. | AUT. | THRT. | _____ 19

ARTICLE	NUMBER	ARTICLE	NUMBER	ARTICLE	NUMBER
Connecting Rods		Governors — Shaft		Oil Piping	
Cranks		Governors — Class A — Waters		Oil Strainers	
Cross Heads		Governors — Class B — Pickering		Oil Stands	
Cylinders		Governor Pulleys		Oil Tanks	
Cylinder Hds Crank End		Grease Cups		Oil Valves	
Cylinder Hds Back End		Knuckle Joints		Pet Cocks for O.C. Basins	
Cylinder Hds Dr's & Pl's		Hand Wheels		Pistons	
Drip Connections		Indicator Gear		Piston Rod Stuffing Boxes	
Eccentrics — Adj. / Solid		Indicator Cocks		Plugs, Frame	
Eccentric Straps		Journal Boxes, Main		Relief Valves	
Eccentric Rods		Metallic Packings		Rockers and Boxes	
Elbows		Oil Catch Basins		Starting Bars	
Flanges, Steam		Oil Catch Cups		Steam Chest Covers	
Flanges, Exhaust		Oil Deflectors		Valves and Stems	
Fittings, W.S. Partition		Oil Guards		Valve Buckets	
Frames		Oil Pump		Valve Connections	
		Oil Cup Sights		Valve Stem Guides	
				Valve Stem Stuffing Boxes	

F 471

RECEIVED BY _____ FOREMAN

The Engineering Magazine

FORM F-471.

Actual size, 4" x 6".

part of, or accompanies, the completed sales product when it leaves the works. Such is iron, steel, paint, slush, wrapping paper, packing lumber, nails, etc. All other material is classed as non-productive and includes such articles as waste, oil, brushes, shovels, coal, gas, water, moulding sand, etc., which are required for operation, maintenance or equipment and accessory to the manufacturing but which do not form a part of the completed product. The general classification of all material and labor is established by a system of standing order numbers as presented by T-3753. The integer in each case indicates the division to which the expense is to be charged, while the preceding figure or figures serve to designate the department. For instance, all numbers for supplies end in "8," while all numbers for the Fan Department begin with "6". Hence, "68" indicates supplies for Fan Department. The proper standing order number when entered upon the material card serves to instantly classify the same.

Group requisitions from the Erecting Department are served on finished stores by means of special forms such, for instance, as F 471, which calls for all the parts essential to the assembling of a given engine.

Oil is stored in tanks beneath a fire proof floor in an independent oil house. Thence it is pumped into individual 10 gallon "pump cans" which are distributed to the various sub-departments.

No. or Size 8 x 10	ARTICLE H.I.C. Piston					Pat. or Pre. No. 731 9161		Dwg. No. 6 588	Weight 50 Cost 3.91	Max. 125 Min. 25 Unit 100	
Date	Ordered	Received	Delivered	Balance	Unfilled Orders	Date	Ordered	Received	Delivered	Balance	Unfilled
1904 10/10				55		1904 12/25				52	
10/15			5			12/27			10		
10/18			1			12/29			1		
10/25			10			1905 1/5		25			
11/2			2			1/7			2		
11/12			1			1/15			5		
11/14			1								
11/24			5								
11/29			2								
12/1	13775 100										
12/2			1								
12/15		25									
		80	28	52							

F 452

The Engineering Magazine

FORM F-452.

F473-S-11-00

NON-PRODUCTIVE MATERIAL CARD.

Use this card for Material on Standing Orders Only.
Do not use it for Material on Shipping and Production Orders.

Date Aug 2 1905

Received from Stores Dept.
Write here name of department delivering article.

For Machine Dept. To be used on Standing Order No. 85
Write here name of department receiving article.

Quantity	ARTICLE	Weight	Price	Amount
One	20 ft length 3/4 rubber hose, steel wound			

To be used for Chipper
Explain here purpose for which article is required.

J E Merrill
Sign here only upon receipt of article. Foreman.

FORM F-473.
Printed on pink paper. Actual size, 4" x 6".

Waste made up into one-quarter pound balls is regularly delivered on Saturday mornings to foremen, in quantities specified on their individual requisitions, and by them delivered to the workmen in their respective departments. Files (distributed from the tool room) brushes, shovels, riddles and the like are delivered only on requisitions from general foremen and are not replaced without the presentation of a new requisition.

A running inventory of finished parts and completed machines is maintained upon cards like F 452. Notations thereon are made upon issuance of production orders, and upon reports of receipts and deliveries from the stores room. The inventory of completed machines serves as the basis of weekly stock lists, copies of which are furnished to local salesmen and to all branch offices.

Detailed production lists (see T-4057) are employed as a basis for determining the drawing, pattern and piece numbers, kind of material and quantities required in manufacturing specific machines. They are also utilized in the figuring of aggregate costs. Every piece is thereby accounted for and there is no reasonable opportunity for omission or inaccuracy.

The methods employed by the B. F. Sturtevant Co. are not those of a ready made system. They have grown with the concern during its progressive life of forty odd years. They fit the business because they are an evolution of it.

HOISTING PRACTICE IN THE PENNSYLVANIA ANTHRACITE REGION.

By R. V. Norris.

THE days when Anthracite coal was largely mined from drifts or tunnels above water level have almost passed into ancient history, and at the present time all but an insignificant proportion of the 60,000,000 tons or more annually produced is hoisted from shafts or slopes. This, with the very large outputs from single collieries, and the low price of fuel, has developed a hoisting practice somewhat unique in many ways, but, while much is well suited to the conditions, there are many survivals of very ancient and extravagant engines and steam plants, which remind one of Bret Harte's lines.

> "Of all sad words of tongue or pen
> The saddest are it might have been,
> More sad than these we daily see,
> *It is, but hadn't ought to be.*"

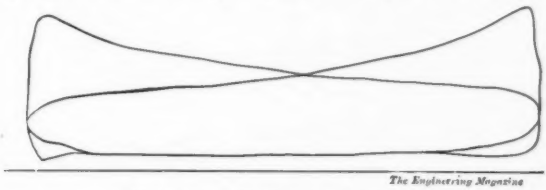
To give an idea of the extent of hoisting done, the last Mine Inspectors Report—1903—states that there were in use in the region 4652 engines of 425,209 aggregate horsepower; this includes all engines, but the greater majority are hoisting engines—2476 cylinder; and 2256 tubular and water tube boilers of 413,441 aggregate horsepower. The antediluvian engines usually go with the equally obsolete cylinder boilers.

The early engines were single engines with hook valve motion, geared to wood lagged drums, often having but a single eccentric. The engine was started with a starting bar before the hook was dropped in place, and lowering was accomplished entirely by the manual moving of the valve with the starting bar. Indicator cards from such an engine without explanation, would be practically undecipherable to even an expert.

Geared engines are still very largely used for slopes and comparatively shallow shafts. Such engines are, however, pairs of modern link motion engines, usually with cast gears and wood lagged drums, and provided with the necessary auxiliaries. These engines

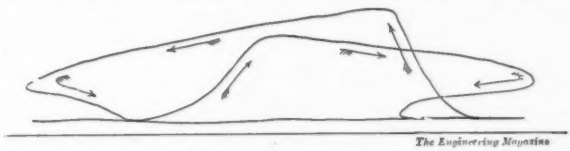
have advantages in first cost—requiring only moderate boiler plants—and are good practice where the time of hoist is not a material factor. The engines are usually of rather long stroke, 18″ x 36″, and 18″ x 48″ being favorite sizes of cylinders. The large diameter drums, required for the large ropes and heavy loads hoisted, are suited to a speed reduction for moderate lifts.

For important hoists, first motion engines are generally used. Such engines are built to rigid specifications, and the requirements



SINGLE, GEARED, 12″ x 14″ ENGINE.
Wood lagged drum. Hoisting.

are most severe, often over 1000 feet per minute piston speed, with reversing under full steam pressure at full speed. The engines are provided with power reverse and brake, cast grooved drums—frequently coned; steel cranks and cross heads; tail rods; special throttle; overwinding valves, and enormously heavy beds.



SINGLE, GEARED, 12″ x 14″ ENGINE.
Wood lagged drum. Lowering.

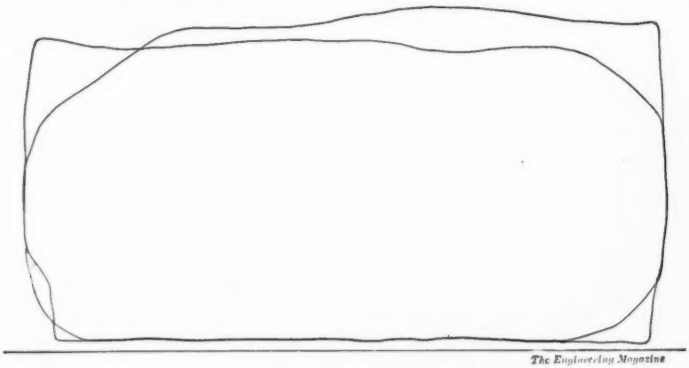
A pair of 36″ x 60″ engines built for the Lytle Coal Co. hoist a tank containing 2,600 gallons (10 tons) of water from a 1,550 foot shaft in 45 seconds.*

To take up in detail the modern anthracite practice in hoisting engines, the bed plates are now usually of the trunk type with bored guides, the bed plate, often made in two parts for convenience in handling, and the end of the cylinder on large engines supported by a special stand. The foundations are usually of concrete, with bolts so arranged that the lower ends are accessible through tunnels in the

* Transactions of the American Institute of Mining Engineers, Vol. XXXIV, page 100. These engines were designed for 110 pounds steam pressure, and every part was made unusually heavy for the very severe work required.

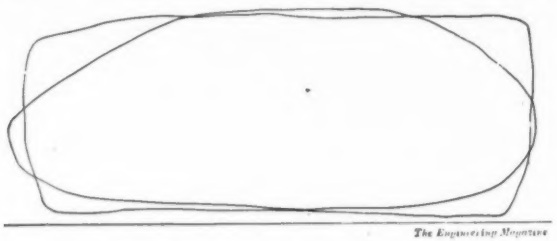
foundation. The bottoms of the bolts are secured either by nuts, locked by special boxes on the foundation washers, or by enlarging the lower end and using keys, the latter practice having advantages in removing bolts in the somewhat circumscribed space or the bolt tunnels.

Cast coned drums, are largely used on first motion engines, these were introduced into the region before 1880, the earlier drums were



FIRST MOTION HOISTING ENGINES, 30″ x 48″.
Short Mountain Slope, Lykens Coal Co.

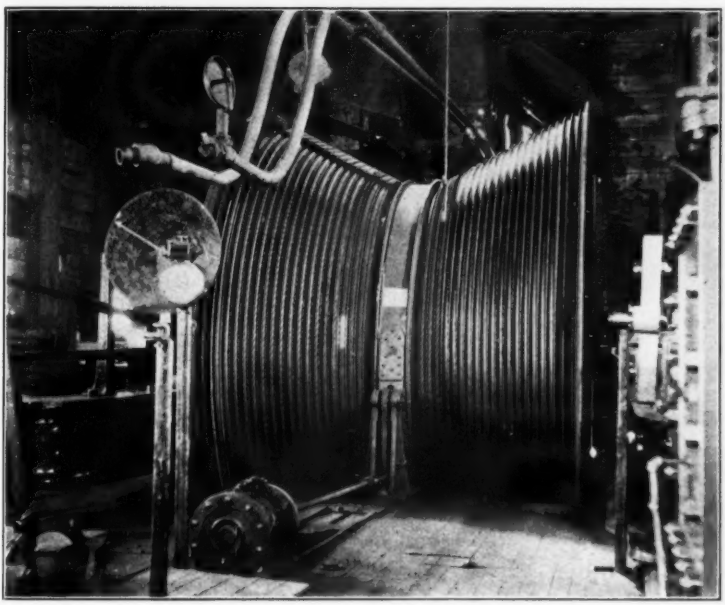
coned toward the centre from a fear that the rope might slip from the cone, this construction, however, greatly reduces the strength of the drum as a beam, and the engines thus designed have always suffered



GEARED HOISTING ENGINE, 12″ x 20″.
Bear Valley No. 1 Shaft, Summit Branch Mining Co.

from breakages at or near the small centre of the drums. As experience proved that the danger of the rope's slipping down the cone existed only in the imagination of the earlier designers, the modern engines are always built with the larger portion of the drum in the centre.

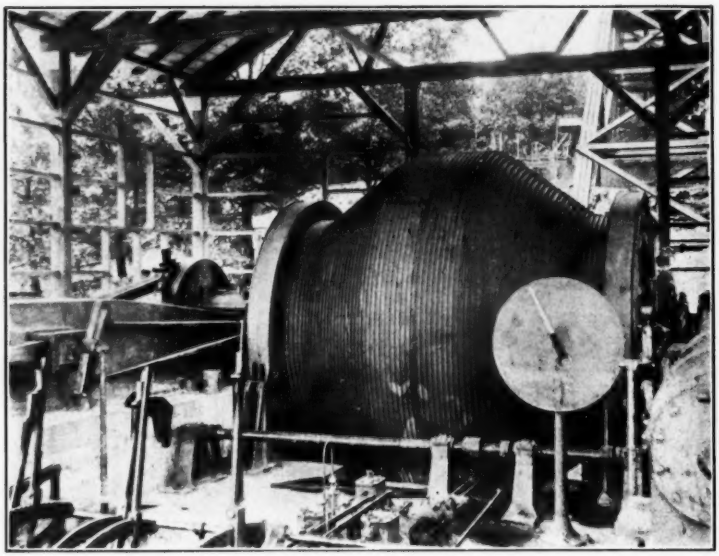
The brake in use is almost invariably of the strap type. The band itself may be wood lined, or an iron band may grip a wood lagged brake sheave or drum; the former has the advantage of cheapness, a single board being bent to form the lagging and it is easier to replace than the blocks required on the sheave or drum. Asbestos lagging is rapidly coming into use, and, when properly treated, is a decided success, showing but very slight wear after years of service. The brakes on the smaller engines are usually hand operated; but on the modern large first motion engines power brakes are in almost uni-



DRUM FOR 30″ X 72″ HOISTING ENGINES, NO. 1 SHAFT, SUSQUEHANNA COAL CO., NANTICOKE, PA.

Built about 1880. Small diameter of drum in center. One of the earliest coned drums built.

versal use. The earliest of these put on in the early 80's was a simple steam cylinder supplied by a three-way valve; this applied the brake with lightning rapidity and resulting shock to the mechanism, and a glorious smoke from the overheated brake band, and kept it on as long as the valve was open, or until the steam condensed after the valve was closed. The brakes on modern engines are applied through a "reversing engine" which moves the brake band in direct relation

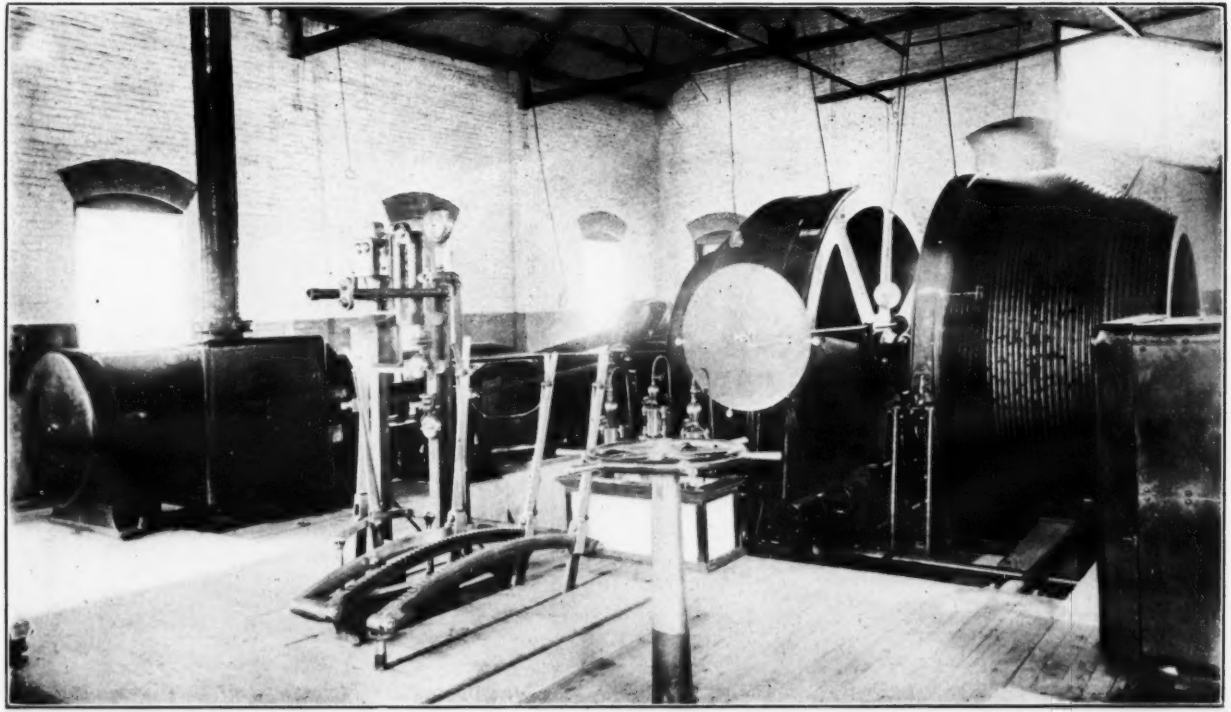


LYTLE SHAFT 36" x 60" HOISTING ENGINE.
Drum coned 10 to 16 feet diameter.

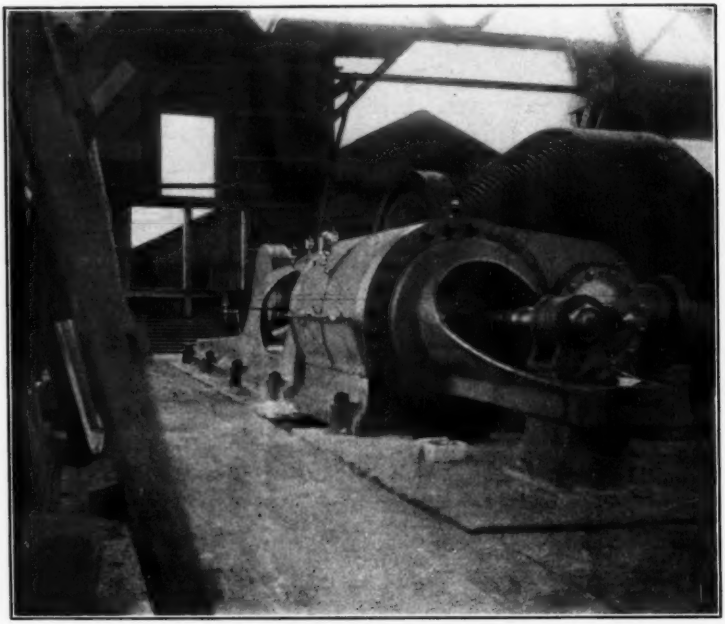
to the movement of the engineers actuating lever. Standard air brakes are also used by which the brake pressure is controlled by the movement of the "engineers valve." With the air brake a standard locomotive automatic compressor is used to supply the necessary air. While the operation of the reversing engine and air brakes are about on a par, the latter has the advantage of "staying put" until released, while the former loses its power by condensation.

In cases where it is necessary to hoist from more than one level in a double shaft, either the well known Whiting system is used, or, more frequently, the engine is built with one loose and one fast drum. The former secured by a jaw clutch is released and held by its special brake, and the change in rope length is made by moving the engine, when the jaw clutch is again engaged. This clutch must necessarily be capable of rather fine adjustment and takes the form of a face wheel of large pitch on the drum, with a similar wheel sliding on the shaft engaging with it as a clutch.

The engine shaft is generally designed as a beam to resist the maximum load on the drum. While this gives an unnecessarily heavy shaft, it has the advantage of very large bearings, and by its small



CORLISS HOISTING ENGINES, 30" x 48". CONED DRUMS, 10 TO 14 FEET. BUILT BY THE VULCAN IRON WORKS, WILKES-BARRE, PA., U. S. A., FOR THE MAXWELL SHAFT OF THE LEHIGH AND WILKES-BARRE COAL CO.



LYTLE SHAFT 36" x 60" HOISTING ENGINE.
Shows tail-rod and drum.

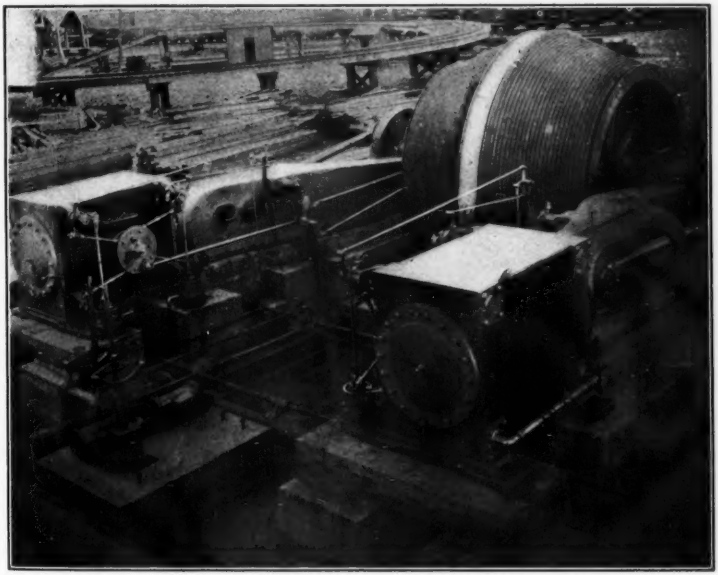
deflection increase the life of the drum. The spiders are of cast iron in halves secured by keys and by bolts shrunk in place. These are of very massive construction and are secured to the drum segments by fitted bolts in reamed holes. Experience has shown that it is constructionally almost impossible to satisfactorily fit the drum and spiders with cylindrical joints, and all modern drums are made either with planed joints on the polygonal faces of the spiders;—lugs on the drum being planed to coincide with these—or with joints in a plane at right angles to the line of the shaft; the bolt holes in the latter case are drilled and reamed in place. Either of these constructions makes a satisfactory and durable drum, while with cylindrical joints constant breaks of the spider bolts and the use of shims between the spiders and the drum are inevitable.

As a further point in drum construction, pointed out by Mr. Behr (Transactions of the Institution of Mining and Metallurgy, London) deep circumferential ribs are satisfactory; but beware of deep longitudinal ribs; they invariably crack at the line of change from cone to

cylinder. Instead use a fillet of ample radius at all re-entrant angles.

For cranks I personally prefer steel castings with cast counter weights; though cast iron balanced wheel cranks are in general use. These may as well be banded with heavy wrought bands shrunk on at first, as this will be done eventually, and it is better to avoid the inevitable cracks in unbanded cranks. The pins are made very large to stand reversing under full steam pressure, and at full speed, and the maximum pressure per square inch of projected section should not exceed 1000 pounds.

All sorts and descriptions of valves are in use in the region. For small and moderate sized engines balanced slide valves are in universal use up to such a size as may be readily reversed by hand. For the larger engines either piston valves or special balanced slide valves are generally used, with a very few corliss valves. The steam and exhaust ports are unusually large to permit at least 1,000 feet per minute piston speed, which with large engines is frequently exceeded. A hoisting speed of 2500 feet per minute in vertical shafts is common.



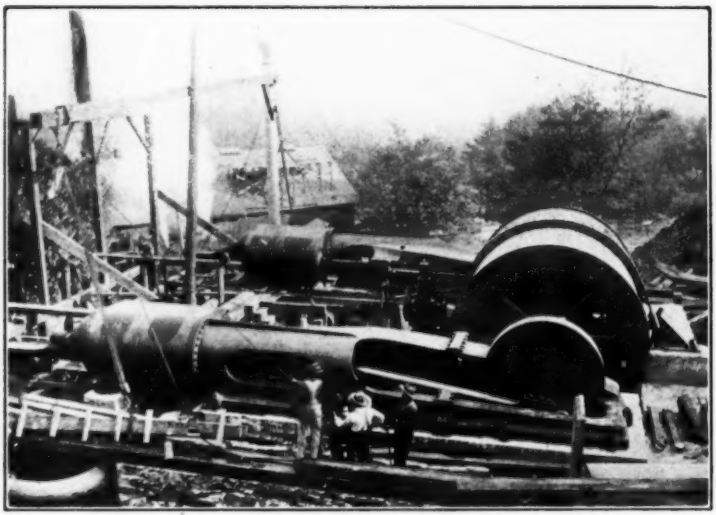
CORLISS HOISTING ENGINES.

Coned drums 10 to 14 feet. Built by the Vulcan Iron Works, Wilkes-Barre, Pa., for the Maxwell Shaft of the Lehigh & Wilkes-Barre Coal Co.

and 4000 feet per minute has been maintained in the middle of the hoist in several deep shafts.

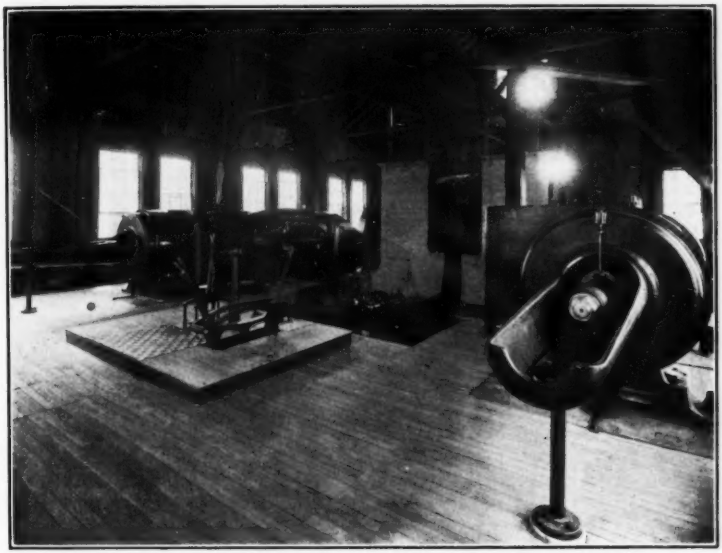
As extremely rapid hoisting and handling is aimed at; steam economy is necessarily a secondary consideration. Typical indicator cards show the steam following about three-quarter stroke. While this is far from economical from the standpoint of steam consumption, the more rapid hoisting often warrants the apparent extravagance, as it does not take very many additional two ton cars of anthracite to pay the entire daily steam expense. It is very easy to cut off the steam in a hoisting engine early enough to materially reduce the daily hoist; and it must always be remembered that, as a rule, the capacity of the colliery is governed by the hoisting and not by the breaker capacity.

The design of engine pistons after many experiments has pretty well settled to a standard of a very light one piece piston with two packing rings sprung into place and steam packed. The face of the piston outside the packing rings is usually turned slightly smaller than the cylinder bore, as a tendency to hug the lower side of the cylinder with full steam pressure on the upper half of the exposed portion of



42″ x 60″ FIRST MOTION HOISTING ENGINES.

Piston valves, wood lagged drums. Built by the Vulcan Iron Works, Wilkes-Barre, Pa., U. S. A., for the Lehigh Coal & Navigation Co., Lansford, Pa.

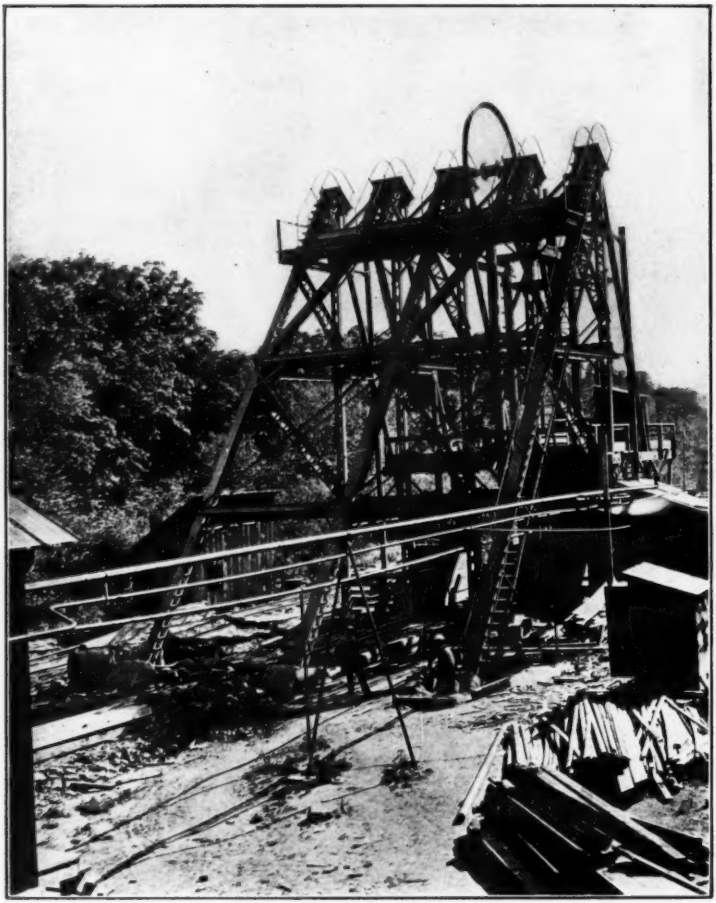


WATER HOISTING ENGINES.

Cylinders, 42″ diameter by 60″ stroke. Direct acting with balanced slide valve. Double wood lagged drum, 12′ 8″ diameter, 14′ 6″ long. Steam brake and steam reverse. Built at the Scranton Works, Scranton, Pa., for Lehigh Coal & Navigation Company. Installed at No. 6 Colliery, Lansford, Pa., by the Allis-Chalmers Co., Milwaukee, Wis.

the piston has often resulted in very rapid wear. Tail rods are used for some of the very large engines, the support being either attached to the rear cylinder head or carried on the foundation. The latter plan has the advantage that with proper design the cylinder head may be removed (sliding out on the tail rod) without much work, and the disadvantage of more difficult and less permanent alignment.

The mining law of the State of Pennsylvania requires "hoisting indicators"; hence all hoisting engineers are supplied with devices to show the position of the cage or car in the shaft or slope. Two general principles are adopted in these, either a disc indicator with revolving hand, actuated by worm or chain from the engine shaft, or vertical indicators in which an indicating finger is hoisted or lowered on a vertical graduated scale. Indicators of the first type are usually supplied with the first motion engines, and of the second type with geared engines; though the type used is largely a matter of the personal equation of the designer, and either is entirely satisfactory.

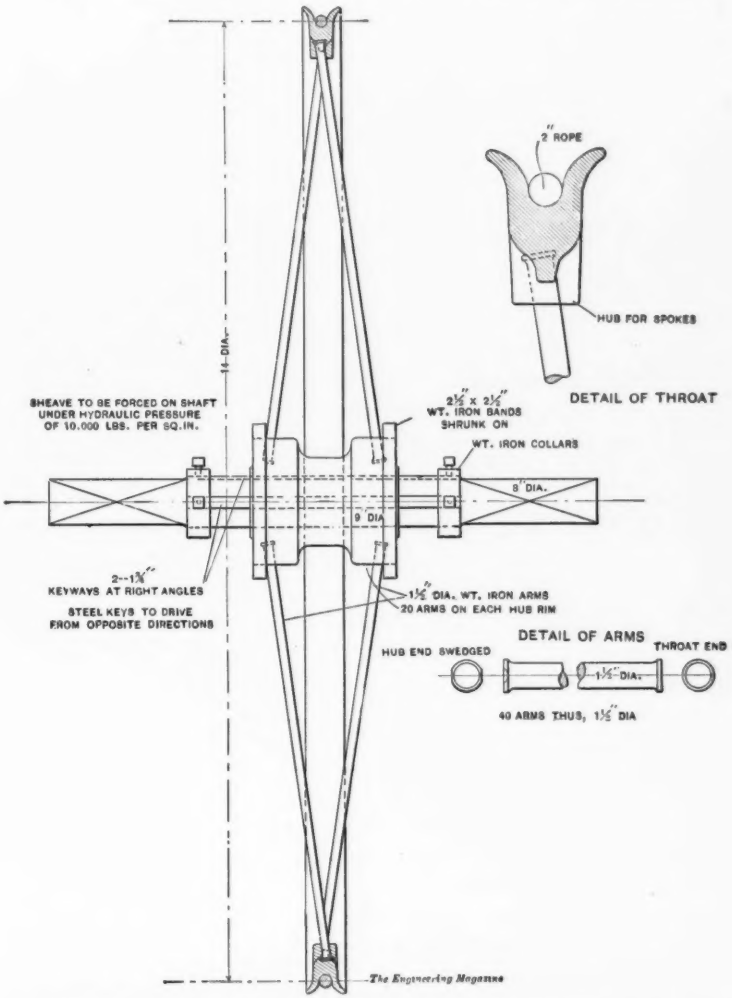


STEEL HEAD FRAME.

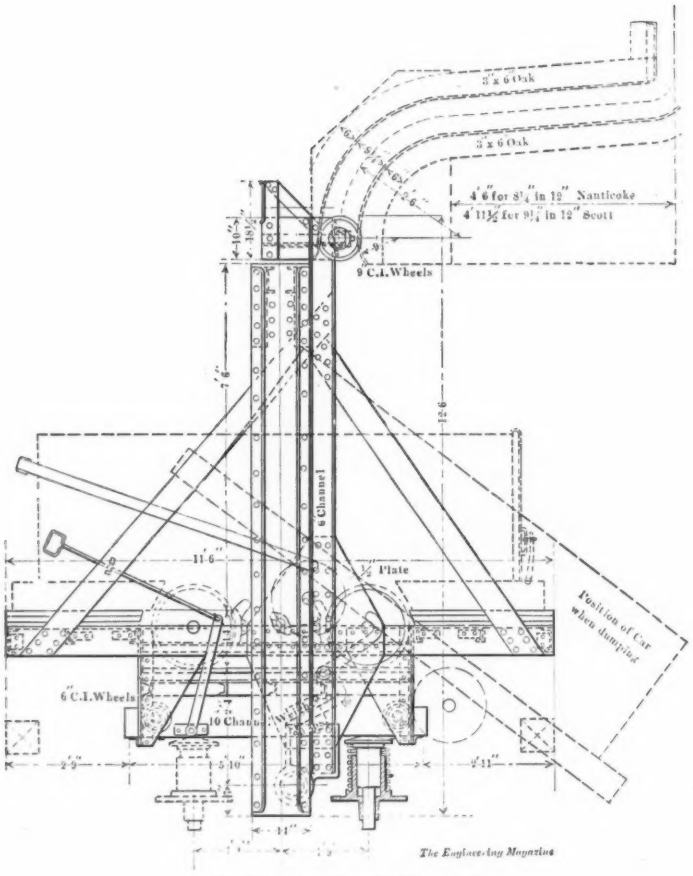
Susquehanna Coal Co., Skarees, Pa.

The reversing of small engines is by the ordinary link motion with a hand lever; but very many of the hoisting engines employed in the region require valves so large that hand reversing is difficult or impossible. Such engines are reversed by enormous links moved by power. The reversing engine employed consists usually of two cylinders, one actuated by steam, the other being an oil cataract

cylinder, the two pistons being on the same rod. The slide valve is connected to the steam cylinder valve, and the valve motion is on a floating centre so arranged that the motion of the piston, and hence of the links, follows exactly the motion of the engineers' lever, so


2" ROPE
HUB FOR SPOKES
DETAIL OF THROAT
14' DIA.
SHEAVE TO BE FORCED ON SHAFT UNDER HYDRAULIC PRESSURE OF 10,000 LBS. PER SQ.IN.
2½" x 2½" WT. IRON BANDS SHRUNK ON
WT. IRON COLLARS
8" DIA.
9' DIA.
2--1¾" KEYWAYS AT RIGHT ANGLES
STEEL KEYS TO DRIVE FROM OPPOSITE DIRECTIONS
1½" DIA. WT. IRON ARMS
20 ARMS ON EACH HUB RIM
DETAIL OF ARMS
HUB END SWEDGED
THROAT END
1½" DIA.
40 ARMS THUS, 1½" DIA
The Engineering Magazine

SHEAVES, 14 FT. SUSQUEHANNA COAL CO. STANDARD, WROUGHT SPOKE.

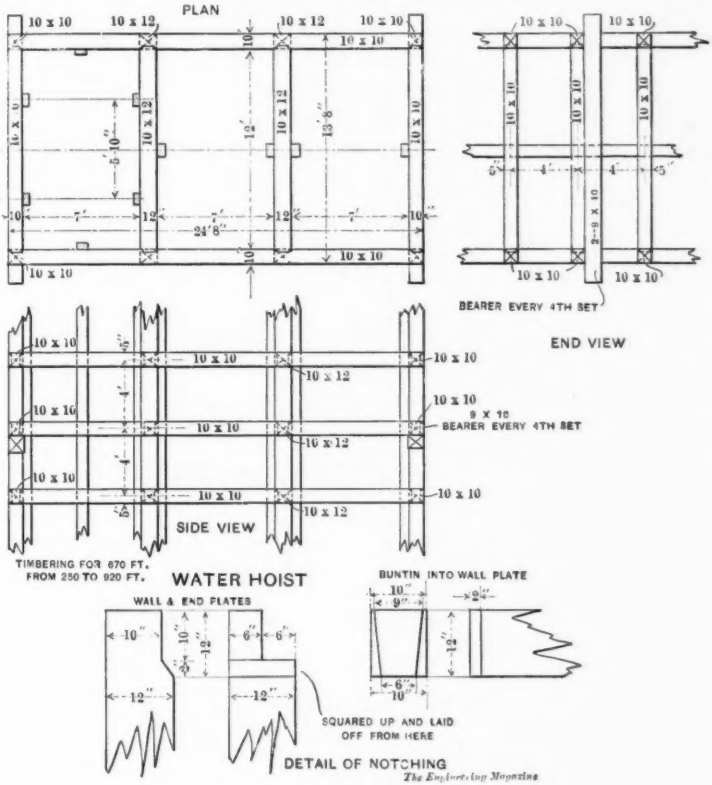


STANDARD STEEL DUMPING CAGE.
Susquehanna Coal Co.

that he can readily and positively set and lock the links in any desired position. The generally accepted plan is shown in the photographs.

Of as much importance as the engines to rapid and economical hoisting, is the detail construction of the shaft, guides, head frame and sheaves. Taking these in their order, the shafts are generally timbered throughout. The timbering consists of square sets at intervals approximating four feet. These sets comprise the side and end plates and buntins separating the hoistways. In loose ground 2" to 3" planks

are placed outside the timbers all around the shaft, with any blocking necessary to support the ground. The sizes of timber used depend on the conditions, the depth and importance of the shaft. The sets


PLAN
10 x 10
10 x 12
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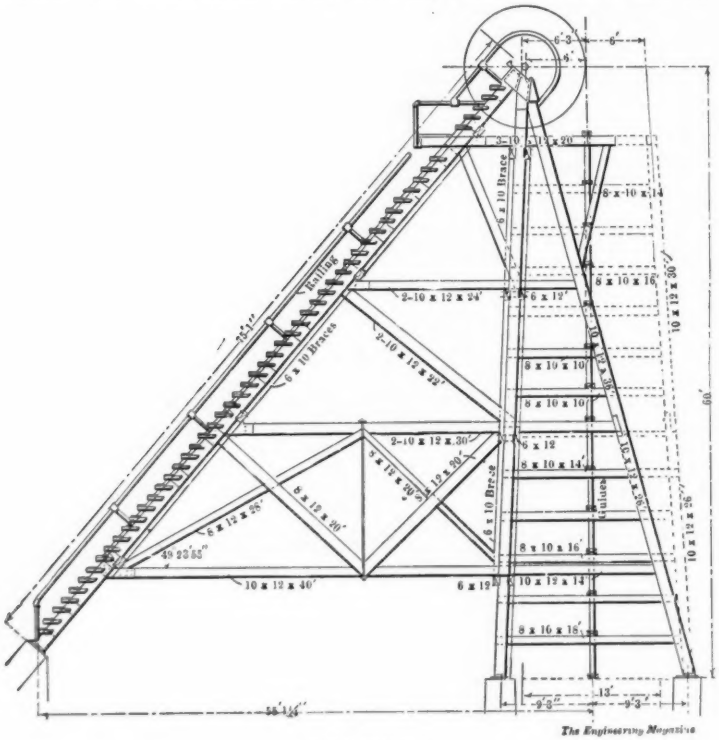
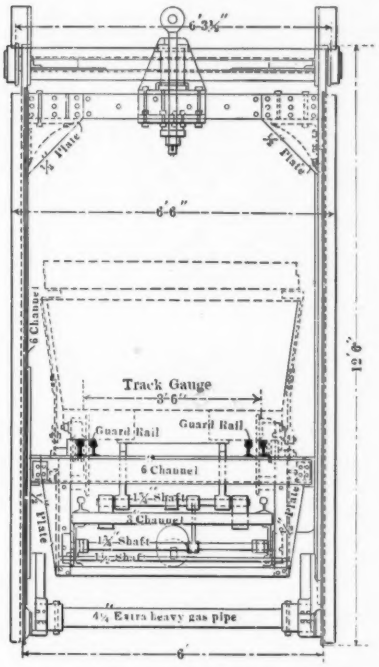
been used in several of the most recent deep water hoisting shafts, as it has been found that the 6" x 8" guides are rather light for the excessive loads and high speeds involved in hoisting water. The vertical guide timbers are secured to the shaft timbering in various ways, depending upon the conditions and more upon the personal equation of the operators. Generally the guides are secured by lag screws, one or two to each buntin. These lag screws are, or should be, so constructed that the solid round shank extends into the buntin, the threaded portion, with cone drive threads being entirely in the buntin. This construction has the advantage that acid water acts on



HEAD FRAME.

William Penn Colliery, Susquehanna Coal Co., Wilkes-Barre, Pa.

the full section of the rod—not on the threaded portion. Another construction in vogue has castings bolted to the buntins, to which castings the guides are bolted with the nuts inside, this materially saves the

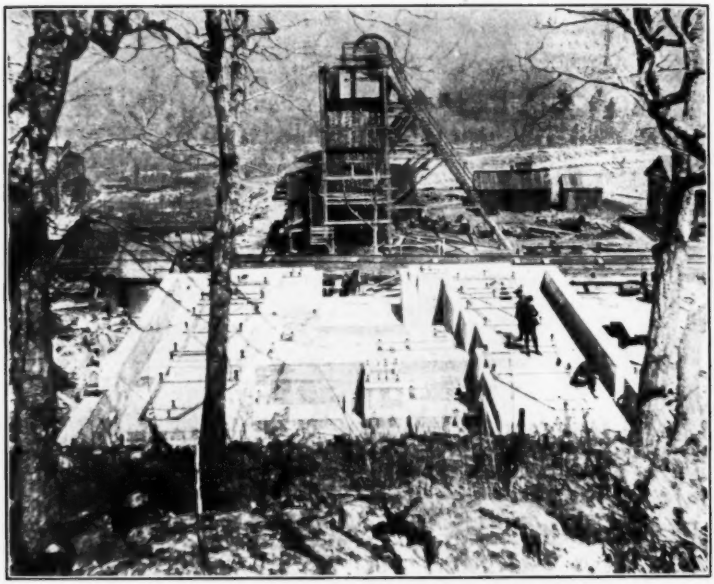


STANDARD WOOD AND IRON CAGE.
Lehigh Valley Coal Co.

buntins; but the nuts usually rust fast and must be cut off the bolts. A third system splices the guides with blocks just above the buntins, the bolts passing through the two guides in adjoining compartments—a very strong construction with the disadvantage of laying both the compartments idle for repairs to guides in one.

Shaft cages are invariably single deck, in contradistinction to the multiple deck cages used in other countries and in metal mining. As the loaded mine cars weigh from 6,000 to 10,000 pounds, one at a time is enough to hoist. The cages are generally of composite construction with steel plate angle guides and timber platform. All wood and all steel cages are, however, largely used. Cages are provided, as required by the State law, with hoods to protect the men, and with safety devices to catch the cages in the event of the breakage of the hoisting rope. That these safety devices are efficient is evinced by the very small percentage of failures in the recent severe and exhaustive tests made throughout the region by the mine inspectors, as the result of a single and unusual accident. Dumping cages are in limited use, generally in "breaker towers" from the surface to the tops of the breakers, though used in a few cases from the mines; these automatically dump the car without removing it from the cage, and materially reduce the time of handling, but they are only available in the few cases where shaft hoists can dump directly into the breaker or into conveyors tributary thereto.

The head frame erected over the shaft is of no small importance. In the general scheme of modern hoisting, the conditions to be filled are ample height and strength, and freedom from disaster. As to the



CONCRETE FOUNDATIONS FOR PAIR OF 36" x 60" FIRST MOTION HOISTING ENGINES.
Bear Valley, No. 2 Shaft, Summit Branch Mining Co.

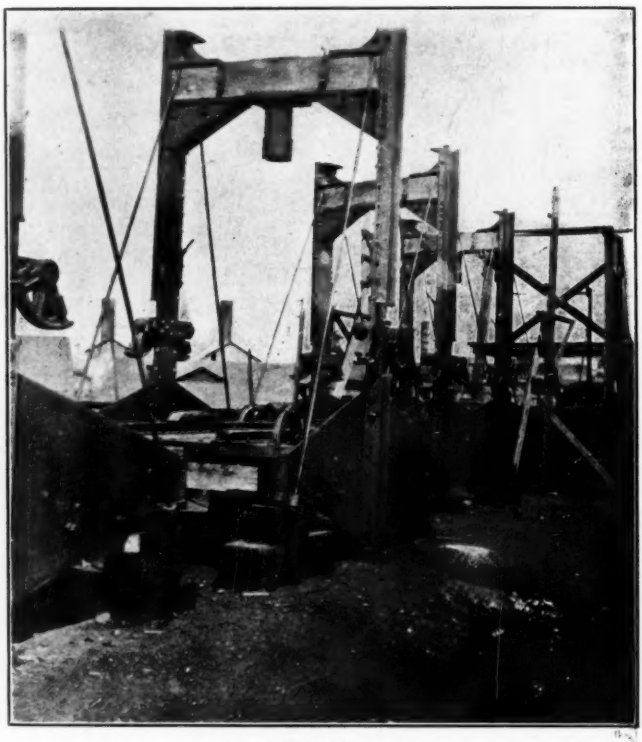
HEAD OF NO. 4 SLOPE, SUSQUEHANNA COAL CO., NANTICOKE, PA.
Slope 3,800 feet long, 5° to 20° pitch pair 26" x 60" first motion engines.
Hoist, four mine cars per trip.

first, the height from the landing to the centre of the sheave has in the last few years, increased from the earlier heights of 20 to 30 feet, to from 50 to 60 feet, in the most modern frames. The increase is demanded by the great increase in speed and the consequent margin required for stopping in the modern engines. Head frames are usual-

STEEL HEAD FRAME. PROSPECT SHAFT, LEHIGH VALLEY COAL CO., WILKES-BARRE, PA.

ly constructed of timber, though steel construction is coming rapidly into use. Three general types are in use. The triangular frame is entirely clear of the shaft, which permits of an overwind with merely the wrecking of the sheave as a penalty, as no part of the frame proper is in the line of the hoist; the only parts of the structure over the shaft are the guide supports. The second type carries the sheaves

on a truss over the frame. This is somewhat lighter than the first type, as the guides are carried by the frame proper; but it has the disadvantage that an overwind will do material damage to the frame itself. The third type has a tension member, it is lighter and lower in first cost than either of the others, but it is more likely to be totally wrecked by an over-wind.

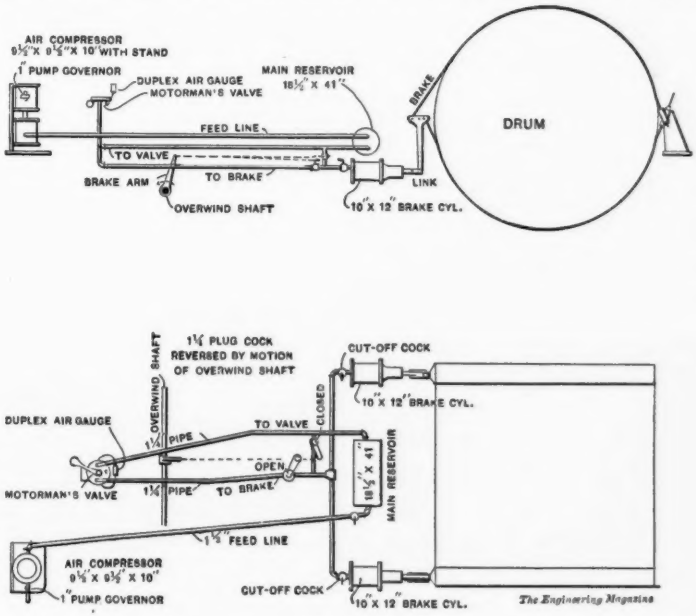


SHAFT CAGES.

Susquehanna Coal Company, Susquehanna, Pa.

The head frame sheaves are usually of the wrought spoke type. These sheaves should be in any event as large in diameter as the drum of the hoisting engine, while many of the larger operators use a sheave even larger than the largest drum as a standard. The earlier sheaves were constructed with wrought arms cast into the rim and hub, the connection being made by grooving the arms, this construc-

tion, while satisfactory for light duty, failed by the breaking of the wrought arms in the grooves. This was overcome by upsetting the ends of the arms and casting them into the hub and rim without reduction of area. Shaft sheaves must be turned true in the grooves as a very small eccentricity results in disastrous vibration of the ropes. A later type takes cognizance of the wear of the rim, and the sheave



AIR BRAKE.

Susquehanna Coal Company Standard.

is constructed with a replacable rim. While this sheave is materially higher in first cost than the usual type, it can be repaired by renewing the rim, while sheaves of the ordinary type are valuable only as scrap when the rim is worn out.

In general, while the hoisting practice is perhaps not up to the most modern practice in steam economy, in speed and in quantity handled it defies competition.

To most men—such as are even engaged in other lines of engineering construction—the mechanical details of mine hoisting cannot fail to be of interest. It is here shown that they are vital to the success of the majority of coal-mining industries.

With many, the mining of coal is classed among the roughest kind of mechanical operations, in which the pick, drill, and mule-car play the most prominent part—an idea which has survived he era of primitive mining operations. Modern mining, however, has been brought to a state of engineering refinement never dreamed of by pioneers of the industry.

To the lay reader the condensed presentation of the state of the art as now conducted, even so far as it relates to the lifting of coal from its normal level to the surface, will be a revelation such, as without expert instruction, could not be gained even by a tour of inspection throughout the anthracite districts.

The manner of obtaining the great supply of fuel, which is so intimately related to the progress of civilization, of which supply Pennsylvania anthracite regions are one of the most important sources of supply, will ever continue to possess an interest superior to that of many industries to which coal-getting is commercially vital.

The facts given illustrate the importance of skillful engineering to mine hoisting, and serve to place in a strong light the great advancement made during the last twenty-five years by careful study and construction. It will be seen that even the smallest details have received attention, and that what might seem of small moment to those unfamiliar with the requirements of coal-hoisting prove upon examination to be far otherwise.

It has been the endeavor to present these details of construction in a concise, yet comprehensive manner, and, at the same time, to enunciate so clearly the objects sought to be attained in each of these details that they will be readily understood by ordinary readers as well as technically-trained engineers.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

I. THE PROBLEM STATED.

This article is the inaugural of a series giving the conclusions of a most valuable practical study of the use of high-speed steel, made in one of the largest American machine shops. The succeeding numbers will set forth the results found under working conditions, pointing out the factors to be considered; the mode of determining when and where to introduce high-speed steel; the advantages and disadvantages of rough forging and large chips as compared with close forging; the handling of steel in the making of tools,—forging, tempering, and annealing; grinding and setting of the tool, and the proper relation of tool and work; relative cost of carbon and alloy steel tools, and the quality of work turned out; new machine requirements, speeds and feeds, and the adaptability of alloy-steel tools to different kinds of work, as well as the jobs to which it is not adapted. It will constitute a complete review of the subject.—THE EDITORS.

MANUFACTURING in the metal trades still lacks much of being revolutionized by the new tool steels with their remarkable properties, as was enthusiastically predicted upon their first appearance as a commercial product. Revolutions do not come so suddenly in industry. It were better to say that they do not come at all, for industrial progress is evolutionary and not at all revolutionary. A new invention does not upset prevailing conditions, but gradually takes its proper place as an economic factor while still being developed to its highest possibilities. And so the new alloy steels, though their capabilities have been by no means definitely determined as yet, are simply taking their place in production engineering while they are still in course of development. In time we may well expect to see marked changes in manufacturing practice growing out of the new conditions which the new tools must inevitably impose. The changes already effected or in sight certainly give promise of still greater things The promise is all the more likely to be fulfilled because the alloy steels are merely at the beginning of their development.

Compared with previous experience, some of the showings that have been made are nothing short of marvellous. Especially is this true in certain cases where tests have been made under very favor-

able circumstances to determine the limits to which these tools could be made to do efficient work. Under ordinary shop conditions and on actual work the showings have been less startling. The ordinary shop conditions, however, are not as yet those that would be expected to develop cutting possibilities to the full; for present machine installations, designed as they are to meet requirements of the old *regime,* do not permit reaching anything near the limit of performance of the new tools. With machine design keeping pace with the development of cutting tools, however, and a better understanding of the properties and behavior of the alloy steels, there is a corresponding increase in efficiency; so that the performances of carbon tools are by comparison very unsatisfactory and often ridiculous. It does not on that account necessarily follow that this indicates the displacement altogether of carbon steel as a material for cutting tools. There are conditions under which a carbon tool will be as efficient as any other could be, and indeed it is a question if for some classes of work it be not much better than one of high-speed steel.

Beyond question the rapid-cutting steels possess qualities making them very desirable in tools; but that is a thing quite different from a demonstration that their use would in all cases be desirable or profitable; for after all is said and done, the question of using the new steels in a shop is mainly a question of their profitableness. If, all things considered, the output is produced cheaper or better than by ordinary tools, then the old order must give way to the new. Nor can the question be decided one way or the other for a whole factory or shop. Its determination is not general, but specific; not for all jobs in general, but for each job in particular. If it were merely a matter of increased output or lengthened life of the tool, there would be no question at all. There are, however, other factors to be taken into consideration, chief among which is the nature of the job itself. For instance, in a job requiring relatively little time for cutting, compared with that used for preparing and setting, there is likely to be little immediate saving, if indeed the increased cost of the tool does not entirely offset the advantage gained. The saving, if any, in such case would be in the time saved in grinding and setting tools. Again, the job may be of such a nature as to make it difficult to hold the piece rigidly enough, or the material may be in such form as to cause many pieces to be inaccurately machined or even broken. A high-speed steel tool is often the thing that will obviate the scrapping of many pieces, and thus produces a saving that may not appear in the piece-work prices at all, where

we usually look for a reduction of cost. Furthermore, in short cuts the working time may be so reduced as to become negligible. The common practice of giving two machines to each man presumes that the cutting time is practically equal to the time necessary for handling and setting. If the cutting time can be so reduced as to make it of little consequence compared with the time for handling, there is no necessity for a second machine. There is then a saving in floor space, and the second machine becomes available for other work or for disposal, reducing the item of capital invested on that job and the related item of depreciation and repairs. Such a case of course assumes the use of equipment already installed. The scrapping of expensive machinery to make way for other of improved design has been practiced to advantage, no doubt, in some well advertised instances, and very likely in many others that have not attained publicity. The present practice in production engineering seems inclined toward the less radical course of utilizing, so far as possible, equipment already installed, adapting it to the greatest possible extent to the new requirements where this may be done without prohibitive outlay, and then getting out of the machinery all there is in it in the shortest possible time, scrapping it when worn out.

The problem is, then, chiefly one of utilizing existing installations. The extent to which this can be done with profit necessarily depends largely upon the capabilities of those machines and the class of work required of them. In general, it may be said that most machines now in use are capable of being speeded up considerably beyond what would usually be practicable with carbon tools—on small jobs at any rate. If the bed be rigid enough, they may be speeded up to the limit of a high-speed tool even. But an increase in speed necessitates an increase in the power required for driving. As ordinarily designed, machines have cone pulleys with face sufficient for the former requirements only, and it is necessary to make provision for the application of the necessary additional power. This can usually be done by substituting cone pulleys of fewer steps and wider faces. There is another limitation to the speed of a machine so adapted, namely the strength and rigidity of the frame or bed. Running at very high speeds there will be more or less vibration and in consequence inaccurate work, saying nothing of the excessive wear on the running parts.

The speed, or rather the extreme lack of it, at which much of the work under the old conditions was (and often still is) done, is distressing to an observer in thorough sympathy with the spirit of this age. He likes to see movement—quick movement—every mo-

ment of time and every expenditure of energy counting for the utmost possible. To see a large piece of metal lazily creeping round and round, the tool paring it down at a snail's rate, is enough to set his teeth on edge because it is so wasteful and unnecessary. Of course the expedition with which wood and similar unresisting materials are worked up is not for metals. At least not yet. Whether in the future metal-cutting tools and appliances will be perfected sufficiently to make possible the working of iron and steel with as much ease as we cut cheese, remains to be seen. The high-speed steels appear to point in that direction; and there does not seem to be any inherently unsurmountable obstacle to the ultimate attainment of so desirable a consummation, distant though it may now be.

Under the old *regime* the limit of possibilities in the cutting tools were reached at relatively low speeds. Twenty feet was about an average, though indeed there were notable exceptions that promised important advancement in the art of rapid cutting of metals. The highest speed successfully attained, so far as shown, was about 100 feet per minute; and this was under the most favorable conditions of lubrication, cooling, and chip removal. The conditions, however, involved a complicated system of appliances that could scarcely be adapted to ordinary work, and that would be so expensive to operate as to be prohibitive; so that a speed half as great may be considered the limit as attained with carbon tools—a limit reached only under conditions not ordinarily found. The advent of self-hardening steels permitted a distinct increase in speeds; but nothing like what is now possible with alloy steels. Since the commercial development of the Taylor-White discoveries, nothing short of bad management would permit the waste of time that used to accompany the taking of long cuts on large pieces. Evidently the day is about past when a workman can or must put in hours at a time idly lounging near his machine, merely keeping an eye on the work to be sure everything is going well, while the machine indolently pares down the piece to the required size and shape. In the machining of such pieces high-speed steel tools fill a long felt want.

In operations upon small pieces reduplicated in large numbers, especially if there is but little machining to be done, as already pointed out the need for increased speed is less evident. The limit of the operator's endurance, and therefore the limit of output, has usually been reached in these cases. The exceptions are those parts produced, or susceptible of production, by automatic and semi-auto-

matic machines requiring little attention and skill in the operator or attendant. The evident lesson here is the same whether viewed from the economic or sociological point of view, namely the development and multiplication of automatic machinery. The sociological aspect of the problem—that is, the influence upon the operator of the deadening monotony involved in feeding stock into and practically becoming part of a machine—is one that must be met in the near future anyway. With the development of high-speed steel tools and machines to use them, the problem (a problem many an employer does not yet know to exist) will become more insistent for solution. The automatic machine seems at present to be the only solution in sight; and the high-speed tool with its lasting qualities is one of the most important features of the future automatic machine.

A serious difficulty in many shops is that of overcoming the lack of uniformity in the hardness of pieces to be machined. Every shop at some time or other has this experience. Gray-iron castings sometimes come so hard that the tools in use, even if of self-hardening steel, make a poor showing indeed. Only a few pieces can be finished without re-grinding and re-setting the tool. The same thing sometimes happens in finishing steel rods and similar parts. An extreme case in point that came under observation was that wherein a shaft regularly made of hard and tough steel at times came so hard that often it was impossible to finish a single piece at a grinding of the tool. More time was used in grinding the tool than in cutting metal. Less extreme cases are common enough. Before the time of alloy steel the working up of such pieces was almost out of the question. A high-speed tool does not balk at hard stock. It cuts both hard and soft indifferently, and if properly treated is about as little affected by one as by the other. The treatment of the tool must, however, be different. In the case above referred to the high-speed tool with which the self hardening one was replaced finished a hundred or more before requiring re-dressing.

The problem of lubrication and cooling, frequently a most difficult one to work out satisfactorily, becomes no problem at all when attacked from the rapid-cutting-tool side. Such a tool ordinarily requires neither cooling nor lubrication. It is true that if used at extreme speeds it is of advantage to keep down the temperature of the tool, as it will require fewer dressings. It may seem absurd to suggest keeping the cutting edge of a tool below a red heat; nevertheless it is actually true that certain high-speed tools often do good work at high temperatures, and have been found efficient when working even just

below a red heat that is barely perceptible in daylight. Such a temperature however approaches the critical limit, and at a red heat most tools quickly break down.

The lubricating fluid, preferably soda or soap water, is undoubtedly useful also in helping to carry away the chips in some cases, and possibly prolongs the life of the tool somewhat. But it may well be doubted if these advantages are sufficient compensation for the inconvenience and expense of a lubricating system, except in instances where it is necessary to cool the piece machined because of its small size and consequent inability to conduct away the heat generated in cutting. In such case it may be necessary to cool the piece to prevent warping and distortion.

There has been a good deal said lately as to whether or not high-speed tools can be used to advantage in finishing cuts. A tool of this sort cuts in a manner entirely different from that of a carbon tool. The latter has a true cutting action; but the former tears off the metal more after the manner of a wedge. The peculiar action of the alloy-steel tool is in part due to its granular structure, which prevents it's holding a sharp and clean cutting edge when in use, as the carbon tool does. In consequence the work done is likely to be rougher than if cut by the latter. Since their first appearance there has been a marked improvement in respect to their ability to cut smoothly and accurately. Such steel can now be had of a texture sufficiently smooth to permit its holding a sharp edge, so that proper treatment and dressing, and a correct relationship of tool and work, will make it possible to do quite accurate finishing with high-speed tools. In general, however, their highest efficiency is in taking roughing cuts or in doing work where extreme accuracy is not required.

When first put on the market the alloy steels were not well adapted to cutting gray iron; and their efficiency in this respect is still below what it is when cutting steel. That is, equally high speeds are not as yet found practicable, though there is no doubt that important economies can be effected in machining gray iron as well as steel. With respect to brass, however, the question is still open to discussion. The savings, if any, are usually small, and are due mainly to the one item of less frequent dressing of the tool.

The final factor in the problem is that of intelligent making and handling of the tools. In a large plant manufacturing its own tools the factor is more important than in a small one buying its tools ready made. Properly treated high-speed tools may now be bought in any form and to meet practically all requirements, so that

it remains only to consider the proper grinding and setting of the new tools. This is merely a matter of educating the operatives, and might be done by an expert temporarily employed for that purpose. Manufacturers of high speed steels furnish printed instructions for the handling and use of their particular product. Such instruction is of course useful, but falls a good deal short of personal instruction and experience; and where it is at all possible to obtain it, such instruction is bought cheaply, even at a high price. In the large plant it is important to have a man in charge of the whole situation who is competent to get results—a man who can himself, if necessary, take a piece of steel, make it up into a tool, and set it at work properly, in addition to being able to determine when and where to use it. Of course, a man lacking some of these qualifications could be of great service, and might develop himself so as to be able to handle the whole situation in time.

The subject of alloy-steel tools, both in respect to their production and practical use, is of serious importance to the metal-manufacturing trades. As yet the subject has been scarcely more than approached, and in the nature of things there can be no definite reduction of practice to recognized standards until there shall be considerable additions to our present experience and knowledge.

It is hoped, however, that the present series of papers will be useful to the extent of bringing together such experiences as may have been found to indicate the probable direction in which standards of practice may ultimately be found to lie.

Summing up the whole situation as it confronts the factory manager, it may be stated about thus:—

Given an equipment reasonably well adapted to the work required and doing it satisfactorily under conditions previously prevailing: What can be done with it in using high-speed steel tools? High-speed tools undoubtedly make possible, in most cases, a distinct reduction in the cost of production; but in order to secure the full advantage—that is, to work them to the limit of efficiency—heavier machinery is required, designed to meet the new conditions. Is it necessary to incur this great expense, or can the present equipment be adapted to permit a profitable substitution of the new tools? Undoubtedly the second course is preferable, except in possible specific instances. The savings will not be so great, in general; but usually it will be the more economical course to use existing installations, adapted so far as possible, until worn out.

Second, shall carbon tools be at once and entirely replaced by

those made of alloy steel? By no means. In many cases doubtless it will be necessary to continue the use of carbon-steel tools, for reasons that will appear in the specific cases. Furthermore, time will be required to find just where the new tools will be of advantage, and to determine just the conditions under which the tool must work in order to get the best results. The change will therefore be a gradual process, each case being considered upon its own merits.

Third, there are certain classes of jobs that can advantageously be taken up first. The most obvious are those where the present working speed seems unprofitably slow, especially large pieces requiring considerable machinery; where the material is so refractory as to wear out the tool quickly; and where an increased speed will permit reduction in the number of machines needed for the work.

And finally, there is the question of getting the new tools started in the factory and the operatives educated to their efficient use. For this an expert ought to be called into service. The novice may be able to make some showing: but in making a change, economy is the thing under consideration, and it is poor economy to buy such experience at so high a price.

COST KEEPING IN CONSTRUCTION AND CONTRACT WORK.

By John P. Cowing.

THE following system of cost keeping in contract work is the result of gradual development in the writer's own work, and is intended to illustrate a good method for keeping the cost of contract work in the main office, which may be hundreds of miles away from the scene of operations. It is a system of daily reports, containing all information necessary to enable the general bookkeeper to keep the cost record up to date with all expenditures properly classified.

The forms illustrated are used in the building of bridges. They can be adapted to any kind of contract work by having the proper kind of work printed under that heading in the first column. This system is accurate and is designed to be kept by the superintendent and cashier in the field, furnishing to the general office each day, not only an account of the previous day's work and expenses, but a summary of the cost of the work, the quantity of work performed each day, the estimated balance of work of each kind yet to be performed, and last but most important, the cost per unit of each kind of work.

Upon receipt of a set of these daily reports, the executive head having the work in charge can tell by a glance at reports, forms No. 5 and No. 6, just what progress is being made, and whether any criticisms or suggestions are necessary to expedite the work or lessen the cost.

My organization and management of a field office is as follows. First, when I am ready to commence work in the field on a contract, I build or rent a small building to serve as an office and tool room. This office is in charge of the superintendent of the work, who is directly responsible to me. A bank account is opened in a local bank in my name, of sufficient size to meet one week's pay roll expense.

FORM NO.1

JOHN P. COWING.
CONTRACTING ENGINEER
620-627 CITIZENS' BLDG

_____ 19

In Account with _____ *Foreman*

Expenses on Bridge at _____ *State of* _____

_____

Contract No _____ *Length* _____

Instructions to Foreman. Date your Bill and Vouchers. Show Date your own time commences and ends, inclusive. Show number of days and wages of labor hired. Get receipts whenever possible and make separate item on bill for each receipt. Show amounts paid and received in the proper columns, and balance, if any, due to or from you on previous account.

DATE.	Voucher No.	ITEMS.	Time.	Wages.	PAID.	RECEIVED.
		Balance Last Account,				

DAILY STATEMENT. SIZE 8½ IN. WIDE BY 14 IN. HIGH.

to be checked upon by the cashier and countersigned by the superintendent. This account is replenished every day by a check sent direct to the bank from the main office for the amount of the expenditures shown on the daily statement, form No. 1, so that the account has always sufficient funds to its credit to meet pay roll and local expenditure.

Any money received by the field office from the sale of surplus material is remitted direct to the main office intact.

The timekeeper keeps the men's time in an ordinary time book. As a check each foreman keeps a time book of his men, and the timekeeper checks with them every night. Each night the day's pay roll, form No. 2, is made up by the timekeeper, one sheet being used for each foreman's crew. These are approved by the superintendent, the original being sent to the main office and the carbon copies placed on a spindle or post file by the cashier, after entering them up in his

FORM NO.2.

DAILY REPORT

JOHN P. COWING, CONTRACTING ENGINEER.

CLEVELAND, O.

Contract No. ..... *Working at* ..... *Date* ..... 190 .

Time Starting Work ..... A. M. *Time Stopping Work* ..... P. M. *Weather* ..... *Wind* .....

	NAME.	Total Time.	RATE.	AMOUNT	KIND OF WORK DONE.

Remarks .....

Correct: *Timekeeper* .....

Approved: *Supt.* .....

NOTE.—This Report must be made out daily and delivered to Superintendent at night.

DAILY PAY REPORT. SIZE 7 IN. HIGH BY 8½ IN. WIDE.

FORM NO. 2

Mr. .....

.....

..... 190....

RECEIVED OF

John P. Cowing,

Contracting Engineer,

430-437 Citizens' Building,

CLEVELAND, OHIO.

Dollars ..... and ..... Cents

Check No. .....

Account of wages in full for week ending

.....

.....

..... Hours @ ..... Cents

.....

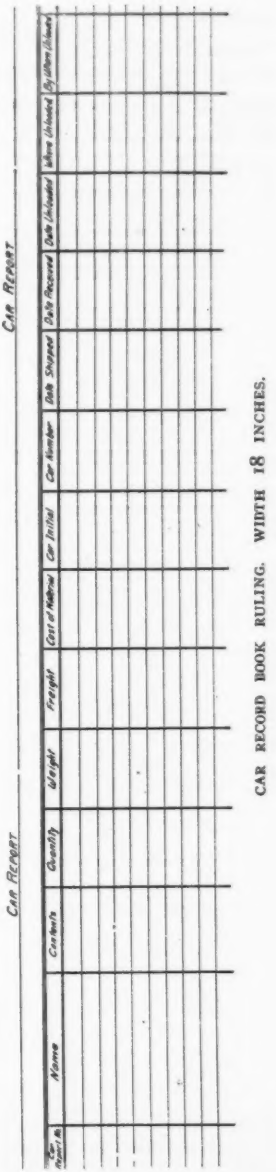
Signed .....

VOUCHER. SIZE 3½ x 7½ INCHES.

office time book. This daily time report compels the timekeeper to check up with the foreman who had charge of each man, in order to enter up the kind of work each man was doing, and consequently reduces the chance for errors in the number of hours of work actually performed.

All blanks are put up in pads, the sheets alternating white and yellow in color. All reports are made in duplicate by use of carbon paper and indelible pencils, the yellow sheet being retained in the field office.

As each car of material is received, the foreman unloading it makes out a car report, form No. 7, which is entered by the cashier in the Car Record Book, form No. 4.



FORM NO. 4.

CAR RECORD BOOK RULING. WIDTH 18 INCHES.

which record book also shows the car record of shipment taken from original bill of lading, both of which together give a complete history of each car. This record book is most valuable in checking bills for material and claims for car service, and it is kept in duplicate, one in the field office and one in the main office. As nearly all material is ordered from the main office, the bills of lading are entered up in the home office car record book before sending them to the field office,

Form No. 1

SUPERINTENDANT'S DAILY REPORT. SUBSTRUCTURE.

JOHN P. COWING, CONTRACTING ENGINEER,

CLEVELAND, OHIO.

Contract No._____ working at_____ Date_____ 190____

KINDS OF WORK.	Work Done Today	Total to Date	Final Total	No. Men	Hours	Rate	Cost for Labor.	Cost per Unit.
Transportation.								
Loading Machinery.								
Unloading Machinery.								
Unloading Piles and Timber.								
Unloading Stone and Gravel.								
Unloading Cement.								
Placing Plant.								
Framing Sheet Piling.								
Driving Sheet Piling.								
Driving Piles.								
Excavating.								
Placing Concrete.								
Dredging.								
Cubic Yards Fill.								

Signed by_____ Sup't.

DAILY REPORT OF PROGRESS ON SUBSTRUCTURE. SIZE 8 IN. WIDE BY 11 IN. HIGH.

and on receipt of the car report showing the unloading, the rest of the record is entered up.

Any special tags or certificates as to quantity of material found on a car are attached to that car report when it is unloaded, and any discrepency is promptly reported to the shipper or railroad company, or both. On receipt of material purchased by measurement such as stone, sand, gravel, piles or timber, each car is carefully measured.

For all material purchased to be delivered by teams, as for in-

FORM NO 6

SUPERINTENDANT'S DAILY REPORT — SUPERSTRUCTURE.

JOHN P. COWING, CONTRACTING ENGINEER,

CLEVELAND, OHIO.

Contract No. _____ working at _____ Date _____ 190__

KINDS OF WORK.	Men Employed Today	Total to Date	Total Value	No. Days	Rate	Total	Cost per Lineal	Cost per Cent.
Transportation.								
Loading Tools.								
False-work.								
Unloading and storing Iron.								
Erection.								
Riveting.								
Bridge Flooring.								
Painting.								
Taking Out False-work.								

Signed by _____ Sup't.

DAILY REPORT OF PROGRESS ON SUPERSTRUCTURE. SIZE 8 IN. WIDE BY 11 IN. HIGH.

stance earth for filling, a receipt, form No. 8, is given to the driver, a carbon copy being kept; the purchase being made on condition that payment will be made only for the amount called for by the receipts.

Pay rolls are preferably paid by checks, and payment made Saturday nights for week ending Friday night, holding back one day's pay to give time to make up the account. Voucher, form No. 3, is used and must be signed by each man.

FORM NO 10

FOREMAN:

Upon receipt of goods check the articles ordered below, and note any deductions or errors, and return this immediately to

JOHN P. COWING From

426 CITIZENS' BLDG., CLEVELAND, OHIO

RECEIVING BLANK Order No. 3186

Date Received _____ Received by _____

RECEIVING BLANK. SIZE 7 IN. HIGH BY 11 IN. WIDE.

FORM NO 7

Car Report. No.____

JOHN P. COWING, CONTRACTING ENGINEER.
CLEVELAND, OHIO.

Date..... 190....

Contract No..... At.....

By whom Shipped.....

Date of Shipment.....

Contents.....

Weight.....

Cubic Yards.....

Car Number.....

Car Initial.....

Railroad.....

Date received.....

Date placed.....

Hour placed.....

Unloaded by.....

Unloaded when.....

Freight.....

Cost of Material.....

Remarks:.....

Correct:

Approved: Foreman.

FORM FOR REPORT OF CARS AS RECEIVED. SIZE 5½ IN. WIDE BY 8 IN. HIGH.

RECEIPT. No. 4955

..... 190....

Received of.....

.....

.....

.....

JOHN P. COWING.

Per.....

RECEIPT FORM. SAME SIZE AS ORIGINAL.

FORM NO 9.

JOHN P. COWING
CONTRACTING ENGINEER
423-427 Citizens' Building
CLEVELAND, OHIO

Order No. 3186
Put this Number on your Invoice.

To _____

_____

Please Deliver Via _____ to _____

The following named articles:

QUANTITY	DESCRIPTION	CHARGE TO.	PRICE		

Mail invoice immediately on shipment of goods
For each order render separate invoice
Order number must appear on your invoice

JOHN P. COWING
Per _____

ORDER BLANK. SIZE 7 IN. HIGH BY 11 IN. WIDE.

Order blanks, form No. 9, are made out in duplicate, one white and one pink, and a third blank of yellow, form No. 10, which is bound next to the pink sheet, and which is known as the Receiving Blank, are used in the purchase of all materials whether by the home or field office. If materials or tools are ordered by the home office to be shipped direct to the field, the yellow receiving blank, form No. 10, is forwarded to the field office and on receipt of the goods, the superintendent returns the blank receipted if the goods are O. K., or with any shortage or damaged goods noted thereon.

For all goods ordered by the superintendent in the field, even if it is only for lantern wicks, he uses the order blanks. The pink copies are kept in a loose leaf binder with alphabetical index known as the unfilled order book, until the yellow receiving blank shows the goods are received, when the pink copy is transferred to a binder known as the filled order book. This method of ordering keeps absolute track of all goods purchased and received, and does away with unauthorized buying.

This system is simple and accurate, and the forms used are the result of numerous trials. They are designed to avoid the cumbersome detail so common in many record forms. It also gives an original detail record of the work, which in case of dispute over payment for extras or otherwise, gives the contractor the advantage of having an original and undisputable record, good in any court.

EDITORIAL COMMENT

THE report of the disastrous boiler explosion which occurred on the gunboat Bennington at San Diego on July 21, last, demands comment for various reasons.

In the first place, it is a matter for congratulation that such an event can be investigated and a report rendered within one month after its occurrence, while the facts are fresh in the minds of the public as well as of those most directly concerned. If disasters can be probed so promptly, it is to be hoped that a corresponding degree of promptness may be found in the investigation of those boilers which have been for many years in use in the navy, and which have not yet exploded; it might mean a saving of life and property as well as of time.

The report of the court of inquiry states that upon arrival at San Diego the ship "was in an excellent state of discipline and in a good and efficient condition, *with the exception of the boilers*" (the italics are ours). The boilers, however, are stated to have been in "fair condition and efficient, considering their age (about fourteen years), and the use to which they had been subjected."

That is, being interpreted, the boilers were old, and had been subjected to usage, the nature of which may be inferred from the treatment given to them on July 21, 1905, on which day one of them declined to be further subjected to such conditions.

According to the report of the court of inquiry, both boilers were filled and fires started, and vigorously pushed under both until the pressure gauge on one boiler showed 135 pounds, while the fact that the gauge on the other boiler stood at zero attracted no attention. Although orders had been issued to reduce the blowing off pressure of the safety valves from 145 pounds to 135 pounds, there is no record that this order had been carried out, nor any evidence that there was any blowing off of steam from either boiler immeately before the explosion occurred. It was also evident to the court that "the hand gear for lifting the safety valves was not in working order, and there is no record, nor direct evidence, that the safety valves had been tested in accordance with the navy regulations."

As a matter of fact, it appeared that communication with the pressure gauge on the boiler had been shut off by the mistaken closing of a valve, and that the pressure, not being recorded, was permitted to increase until the furnace flue collapsed. The men directly concerned in this mistreatment of an old and neglected boiler lost their lives in the disaster, and the court of inquiry recommends that the officer in charge be tried by court martial for neglect of duty.

* * *

THERE has been shown in some quarters a disposition to use this incident as a reason for a wholesale condemnation of the workings of the personnel law, the act by which the old distinctions between line and staff officers in the United States navy were done away, and all were supposed to be rendered capable for engineer duty. On the contrary, the Bennington affair is a striking illustration of the consequences of the non-enforcement of the

law, in so far as it was the intention to make all officers engineers in fact and not solely in name. Had the personnel law been carried out as was the intention of the able and earnest officers by whom it was framed; had the expressed views of Mr. Roosevelt been carried out when, as Assistant Secretary of the Navy, he said: "What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern line officer," we should not have had a young ensign, scarcely out of the naval academy, placed in charge of the engineering equipment of such a vessel as the Bennington, with but a few machinist artificers under him.

In 1899, when the personnel bill became law, Admiral Sampson, who himself had been an active member of the Personnel Board, issued an order to the North Atlantic Squadron showing how he thought the law should be carried out, this method being the assignment of duties as follows: To all officers below the grade of junior lieutenant the duties of engineer officers for one month, and to all assistant engineers the duties of line officers for the same space of time, these duties to be alternated thereafter every month, in order that all officers should become thoroughly familiar with the demands of all departments of the service.

With such an active training in the real duties of the naval engineer, and with such a sufficient force as a gunboat like the Bennington should have had, there need have been no necessity for such a report as the present Board of Inquiry has had to make, no damaged vessel, no deplorable loss of life. Officers fully trained by practical experience in the necessity of seeing for themselves that their orders had been obeyed, and not merely content with issuing directions to incompetent and neglectful subordinates, would never have permitted the equipment to have reached the condition which naturally resulted in the disaster on the Bennington. It is not the personnel law which is responsible for the present state of affairs, but the persistent and deliberate neglect to enforce that wise and important statute in the spirit in which it was conceived and in which it was intended to be executed.

* * *

We have reviewed at length elsewhere the report of the Royal Commission upon London traffic conditions, but we cannot emphasize too strongly the importance of the possibilities for improvement by diminishing the necessity for crowding the streets, rather than by providing increased facilities for enabling more people to move about. Formerly the only way of communicating with another man was to go to him, or to send some one else. With the introduction of the railway, the post-office, and the telegraph, much of this necessity has been removed. By the provision of a full, prompt, and wholly adequate telephone service a very large portion of the crowding of city streets might be avoided, and this, too, with a promptness which no system of new and enlarged highways could approach.

Many people seem to have the idea that business energy and effort consists in "taking cabs and going about," or in chasing with feverish activity about the streets, endeavoring to meet and talk with people who themselves are as busily engaged in trying to get to others. It is this feverish perpetual motion, resembling nothing so much as the movements of a host of animalculæ in a drop of water under the microscope, which causes much of the congestion in the streets of a great city, and the greater the facilities provided for such wasted energy, the greater will the congestion become.

THERE is another kind of congestion, that due to the daily flow of people from the residence to the business districts and back again, and this can be provided for, to a certain extent, both by greater facilities and by judicious regulation. A large part of the crowding of transport vehicles is due to the fact that the local and the long distance services are not separated to a sufficient degree. Usually the business district of a city is closely condensed and centralized, and while densely populated during business hours, its traffic is also concentrated to a few hours in the morning and evening, at which time the greatest congestion occurs at certain limited areas. By providing suitable express trains, preferably running underground, but possibly overhead, and by separating this service entirely from the local transport provisions, it would be possible to run a number of through trains from the business district to the extreme outlying suburbs without any of the delays invariably included in local transport, the result being a rapid clearing of the congestion at night and a corresponding development of suburban residence districts of but moderate population density. In such a system there should be no conflict of human currents, no mixing or confusion between local and express passengers, and above all no contraction of the flow of people in boarding the trains, since most of the congestion at stations is due to the delays in getting the passengers from the platform to the cars while others are crowding on behind them. The modern engineer should be capable of designing something far superior to the present obsolete car with its ancient platform, an inheritance from the days of handbrakes, and give us one which shall enable a crowded platform to be cleared in the time required to pass freely over the few feet of distance involved. When a great exhibition, or even a racing event or athletic game, occurs, the railway authorities understand very well how to handle the crowds which they know will be clamoring for simultaneous transportation, and every one is familiar with the efficient manner in which long trains are rapidly supplied and as rapidly dispatched from the grounds to the homes of the multitude. The same methods, even intensified in vigor, applied to municipal transport, would work wonders, and their application might be made with but moderate delay.

* * *

THE commercial traffic of the great lake system of North America is growing at an astonishing rate. From the Monthly Summary of Commerce and Finance of the United States for June, 1905, an adequate appreciation of the marvelous increase of this commerce can be gained. The total volume of freight received at the various ports for the first half of the current year was 19,806,321 tons, of which 10,297,436 gross tons were ore and minerals, not including receipts of coal, of which the total was 3,829,630 tons. Through the Sault Ste. Marie canals the traffic for the first half of the current year exceeds that of 1894 by nearly 10,000,000 tons.

The character of this great traffic can be judged by the fact that in addition to the transportation of ore, coal, and other minerals, as above stated, the traffic included 295,000 tons of flour, 39,719,967 bushels of grain and flaxseed, and 625,549,000 feet of logs and lumber. Of unclassified freight, 1,722,414 net tons were transported. The conception of such a vast tide of commercial traffic cannot be made vivid by figures or bald numerical statements, but a comparison of these figures with those of years past will place in a strong light the importance of the lakes to the internal commerce of

North America, and to the manufacturing industries supplied with raw materials through this route.

* * *

WE have referred elsewhere to the influence which the full use of methods of communication, such as the telephone, pneumatic dispatch, etc., may have upon the congestion of streets in the business sections of large cities, and there is ample evidence to show that this method of relief is not used to its full capacity in any place. Much depends, doubtless, upon the character of the service given by a telephone company, for example, and something also upon the system employed; but so far as advantages are concerned, there can be no question as to the influence of the telephone as a means of aiding in diminishing the necessity for going about in the conduct of business matters.

The recent inquiry of the Merchant's Association of New York into the question of telephone service in Now York City revealed some interesting facts in this connection, showing not only the important relation which the telephone bears to the development of business and industry, but also the extent to which the conduct of the telephone service has become an engineering matter, involving methods and appliances wholly within the province of the engineer. Thus the introduction of the system of service charges for telephone use includes the necessity for some form of mechanical counter and recorder for keeping account of the number of calls made by each subscriber and of the districts between which the service is rendered.

Methods of determining the cost of the service have been put into use, these methods resembling closely the modern systems of works management which have been so efficiently developed of late, the costs and charges being based upon the service rendered.

The result has been a great increase in the use of the telephone in New York, that city now being far in the lead of all others.

Thus, according to the latest census reports for 1904, there were in the boroughs of Manhattan and Bronx 65 telephones per 1,000 of population, while the corresponding figures for London are but 14.2, for Paris 18.5, for Berlin 34.5, and for Vienna only 12.1. These figures are interesting, but they do not tell the whole story, since it is not only the number of telephones, but the activity with which they are used, which is the measure of their efficiency.

Any one who has attempted to save time by using the telephone in London well knows the inconvenience caused by the dilatory and unsatisfactory service, and can understand the reason why the business man prefers to incur the expense and time required to take a cab and make a personal visit rather than to attempt to depend upon the telephone.

The application of engineering methods, both in construction and operation, has resulted in giving the residents of American cities greatly improved telephone service at a diminished cost, and similar methods applied to the prompt delivery of local letters, either by pneumatic dispatch or some analagous system, would give corresponding aid in reducing the congestion on the streets.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ENGINEER AS AN INVESTIGATOR.

THE WORK OF THE TESTING ENGINEER IN THE STUDY OF THE PROPERTIES OF MATERIALS OF CONSTRUCTION.

Charles B. Dudley—American Society for Testing Materials.

IT is very common to regard the engineer as a man who does things, both by making the designs and by superintending the work of construction, but there is another phase of engineering work which may be likened to that of the detective, the searching out of the causes of occurrences, tracking the faults and defects of materials and structures to their origin, and enabling the responsibility to be placed and the repetition of accident to be avoided. This department of engineering has developed rapidly of late, and the testing engineer, as he has been called, holds an increasingly important position in the work of all departments of applied science.

In the presidential address of Dr. Charles B. Dudley, delivered before the American Society for Testing Materials, the work of the testing engineer is discussed in a very interesting manner, by one who has had an extended experience in this valuable department of engineering.

"It is plain that the testing engineer acts in a three-fold capacity. He is either an investigator, or a counsellor, or a judge. He is finding out new truths, he is protecting the interests of his client the producer, or he is determining by his tests that contracts are being fulfilled, or specifications lived up to, in the interests of his client the consumer. There are three kinds of testing engineers, the unattached engineer, the consumer's engineer, and the producer's engineer. It did not take long after consumers began to test materials and prepare specifications before producers found it necessary to protect their interests and defend their materials by means of testing engineers in their own employ.

"What shall be the cast of mind, and what the mental equipment of the testing engineer? We will perhaps all agree that he should be independent, self-reliant, gifted with the power of analysis of facts, as well as with the power of drawing conclusions from the data at hand. He should be ingenious in devising methods to demonstrate the points at issue, and a careful observer of data. He must keep himself free from bias or prejudice, and take especial pains that he does not deceive himself. He should be fond of experiment and have a genius for it. Above all he should be a thinker. No man who, when a problem is presented to him, simply searches his memory for whatever he may have learned in the schools, or picked up in his reading, which bears on his problem, has any especial call to be a testing engineer. The power of seeing analogies between your own problem, and one that some one else has had, is legitimate and useful, but the one who habitually and continuously approaches every problem through memory, or by studying up what others have done, is far less likely to succeed as a testing engineer than one who habitually attacks a problem by an analysis of its elements.

"But if experimenters are born, not made, what can the schools do in the way of training? Given fair mental endowment, it is possible for the schools to make suc-

cessful testing engineers, or to spoil the material they start with.

"But the mental equipment which the schools furnish is only a fraction of that needed by the testing engineer, especially if it be his duty to defend the interests of a great consumer. The schools should teach a young man how to learn, and should start him in a number of subjects, but his real education comes later. The man who expects to reach even moderate success as a testing engineer, must study harder the first five or ten years after graduation than he did at any time while in school. He must accumulate experience by arranging the information already acquired by reading, by study, and actual contact with industrial processes, and with the world's work, in every possible detail, and above all, a man must acquire experience by actual wrestling with problems that may be committed to his care. It is apparently not essential, in order to gain experience, that one should successfully solve his problems. Faraday was accustomed to say that he actually learned more by his failures than from his successes. The testing engineer should be an omnivorous student. Nothing is too trivial to interest him, nothing too remote from his present line of work to make a legitimate demand on his attention should opportunity offer. You can never tell what moment you will need, and badly need, some out-of-the-way fact."

Dr. Dudley gives some interesting examples of the manner in which the testing engineer following out a line of reasoning from the inspection of a piece which has failed, such, for example, as a broken car axle. Here an examination of the fracture and of other parts of the axle, combined with a knowledge of the methods of manufacture of the material, leads unerringly to the cause of the failure, and to the precautions to be taken to prevent its recurrence. Other examples are given, showing the great value of proper supervision and inspection, and this, together with a close following up of innumerable indications, which, to the ordinary observer might be almost imperceptible, but to the trained eye of the testing engineer lead to the revelation of the true condition of affairs.

"It may seem an idle question, but it is certainly an interesting one, as to which of the three kinds of testing engineers has the most attractive field of work. The unattached testing engineer certainly has the greatest freedom, but at the same time, the least stimulus. The producer's testing engineer undoubtedly has the best financial reward, but at the same time the narrower field. He has, however, the advantage of concentration, and as almost every modern industry has scores of unsolved problems connected with it, there is no reason, if he will work, why he should not achieve a great success. On the other hand, the consumer's testing engineer has unquestionably the broader field, the greater chance for initiation, and perhaps more important than all, an opportunity to study the behavior of materials in actual service. This last gives him a great advantage. Behavior in service is unquestionably the ultimate criterion by which every industrial product must be judged, and by which decision, sooner or later, it must stand or fall. Undoubtedly individual characteristics are a legitimate element in the choice, but our counsel would be to every ambitious testing engineer to get as near to the service as possible, and to this end to make some sacrifice if necessary to secure a position with a consumer.

"There is one more phase of the work of the testing engineer which will perhaps bear a few words, and that is the relation between the testing engineer and those whose material he is testing. This is unquestionably a delicate subject, one that we would all gladly feel did not need discussion or comment, and yet one that is constantly thrusting itself into prominence in some form. For the honor of human nature, it is gratifying to be able to put on record that during nearly 30 years of almost constant testing, only once have direct financial considerations been urged upon us to influence our verdict in regard to material. On the other hand, we have heard representatives of entirely reputable business organizations say openly, 'It costs us something to sell our goods, and it is entirely immaterial to us whether this money goes to our selling agents, or to the representatives of the consumer.' And this is not the worst phase of the matter. It is well known that the representatives of consumers who act in some sense in the

capacity of testing engineers, in that their opinion or decision determines the giving of orders, not only accept substantial considerations from producers, but even demand them, if not openly, at least indirectly. An hour could readily be filled in narrating incidents of showing the forms in which the hydra-headed monster graft manifests itself. Neither side is free from blame. Strict open honesty is the only safe course. It may not be amiss to add that so insidious are the forms in which this evil manifests itself, that in the words of scripture they would at times deceive the very elect, and while it is not possible to discuss these matters, without raising interminable questions of casuistry and metaphysics, it is possible to so act as to have the continuous approval of a clean conscience. No universal rule can be given. Each one in a sense must be a law unto himself. Perhaps the best every day working rule for young testing engineers is, do nothing you would not be willing to talk over with your employer, even in the presence of the other party. It is sometimes a bit hard to resist and say 'no,' but of one thing be sure, every departure from strict integrity will sooner or later return to plague you, and should your actions ultimately result in your downfall, from none will you get less sympathy than from those who may have contributed to your disaster."

STEAM TURBINES IN MARINE SERVICE.

A PRACTICAL COMPARISON OF THE PERFORMANCE OF STEAMSHIPS EQUIPPED WITH STEAM TURBINES AND WITH RECIPROCATING ENGINES.

William Gray—Institution of Naval Architects.

ALTHOUGH much of the recent development of the steam turbine has been in connection with stationary service in electric generating stations, the earliest applications were for marine propulsion, and it is in this department of engineering that the turbine may find its most important use. For this reason the paper presented by Mr. William Gray before the Institution of Naval Architects upon the performance of the turbines installed in the Irish steamers of the Midland Railway Company is of interest, especially as it gives reliable data upon the comparative performance of both turbines and reciprocating engines in vessels of similar dimensions and construction in identical service. The discussion is of the more acceptablity since it was by the author, in conjunction with Professor Biles, that the vessels under consideration were designed.

"After careful consideration of the data available, the Midland Railway Company decided to fit two of the vessels of their new fleet with reciprocating engines and two with Parsons marine turbines. Three of the vessels, the *Antrim*, *Donegal*, and *Londonderry*, were intended for the Belfast passenger and cargo trade, and the *Manxman* for the Isle of Man summer passenger traffic, although she was also fitted with portable cabins for taking up the Belfast trade in winter. The principal dimensions of the three former vessels are as follows: Length on the water line, 330 ft.; moulded breadth, 42 ft.; moulded depth, 25 ft. 6 in. The *Manxman* is similar in form, and of the same length and depth, but the moulded breadth is 43 ft.

"The working pressure in the *Antrim*, *Donegal*, and *Manxman* is 200 lbs. per square inch, and in the *Londonderry* 150 lbs. per square inch. Forced draught on the closed stokehold system is fitted in all the vessels. The fans for this purpose are driven by electric motors in the *Antrim* and *Donegal*, and in the *Londonderry* and *Manxman* they are driven by steam engines. The engines of the *Antrim* and *Donegal* differ only in detail. They consist of two sets of the 4-cylinder, triple-expansion type, each driving a 3-bladed propeller. The cylinders are 23 in., 36 in., and two of 42 in., by 30 in. stroke. The auxiliary machinery in all the steamers is of the most modern type, and as the pumps are driven independently a better comparison is afforded of the performances of the propelling machinery.

"The arrangement of the turbines in the *Londonderry* and *Manxman* differs only in detail, but the turbines in the *Manxman* are

larger, as they were designed for 25 per cent. more power than the *Londonderry*. The *Manxman* is also fitted with Parsons' vacuum augmenter. In each vessel there are three turbines, one high pressure and two low pressure. With the latter are incorporated the reversing turbines that work *in vacuo* when not in use. Each of the three turbines drives a separate shaft, and a three-bladed propeller. The low-pressure turbines are on the outer shafts, and the high-pressure turbine on the center shaft. All the turbines in both ships were made by Parsons' Marine Steam Turbine Company."

In considering the performance of the two systems comparison should be made between the *Antrim* and the *Londonderry*, since the *Manxman* is the higher powered vessel, but the data of all the vessels are interesting. Thus the conditions of the contract were that the vessels should maintain a speed of 20 knots for six continuous hours under two-thirds boiler power, while on the trials the *Antrim*, with reciprocating engines, made 20.6 knots, and the *Londonderry* 21.6, and the *Manxman* 22.65 knots, the last two being the turbine vessels.

The water consumption during the trials is tabulated in the paper, both for speeds from 14 to 21 knots, and above 20 knots for the faster steamers. No comparison upon indicated horse-power was practicable, owing to the impossibility of measuring the indicated power of the turbines.

The figures throw some light on the relative economy not only of the two systems of propulsion at various speeds, but on the different arrangements in the two turbine steamers themselves. They show that from 14 knots to 20 knots the turbine is more economical. The maximum difference occurs between 19 knots and 20 knots, which is the working speed of the vessels on service. In the case of the *Londonderry* the decrease in water consumption amounted to 8 per cent., and in the case of the *Manxman* to 14 per cent., as compared with the *Antrim* and *Donegal*.

The paper contains a tabulated statement of the coal consumption of the several steamers from September, 1904, to June, 1905, not including the fuel burned while in port, and ignoring the differences in speed and coal consumption due to the relative weights of the turbines and the reciprocating engines, the intention being to consider the subject directly from the viewpoint of the shipowner.

"The results point to a marked decrease in the coal consumption of the *Manxman*, as compared with the *Antrim* and *Donegal*. The *Manxman* did 20.3 knots for the same coal consumption that the *Antrim* had at 19.5 knots. A similar comparison of the *Manxman* with the *Donegal* gives nearly the same results. The performances of the *Londonderry* are nearly as efficient as those of the *Antrim*, but they are better than those of the *Donegal*. They also indicate that the *Manxman*, with higher steam pressure, a smaller number of revolutions and larger propellers, has done better than the *Londonderry*.

"A further economy in the turbine steamers is effected in the amount of oil used for lubrication. The logs show that this amounts in both steamers to five gallons per single trip. This again permits a further economy in the reduction of the engine-room staff from four greasers to two. Speaking generally, therefore, the performances of the turbine steamers, especially the *Manxman*, have been greatly superior to those of the steamers fitted with reciprocating engines.

"It is not possible to make a quantitative analysis of the cost of upkeep, but so far the turbines have cost practically nothing, and they require very little attention compared with what is necessary in the very best-running engines of the reciprocating type.

"There can be no doubt that one great benefit derived from the use of turbines is the elimination of the vibration inseparable from the use of reciprocating engines in Channel steamers. The engines in the *Antrim and Donegal* were most carefully balanced, and the vibration at the service speed is almost imperceptible. The almost unanimous testimony, however, of those who have travelled in the vessels is that the turbine steamers are steadier.

"The only real inferiority in the *Londonderry* and *Manxman* is the difficulty of manœuvring from rest in narrow waters. In this respect they compare unfavorably with the *Antrim* and *Donegal*. No doubt

with further experience those in charge will become more expert in working with the small screws, but for turning from rest there is smaller power in the side propellers. Experiments were made at the trial trips that showed the turbine steamers going at full speed could be brought to rest in about 1½ minutes. This is a good result, but actual experience has shown the relative inadequacy of the backing power starting from rest. There is no good reason why sufficient backing power cannot be obtained from small screws if the reversing turbines are made powerful enough."

So far as the elements of space, weight and cost are concerned, these demand some consideration. The turbines demand much more floor space than the reciprocating engines, and while this is accompanied by a gain on upper decks, the space above can be utilized only by reducing the light and air space to the turbine room. According to the tonnage laws, this may act to increase the net tonnage of the vessel, and where the tonnage dues are heavy this may balance the commercial gains in oil and fuel.

There is a considerable gain in weight in favor of the turbine steamers, the difference between the *Antrim* and the *Manxman* being about 115 tons, or about 6 per cent. on the light weight of the steamer.

The difference in the initial cost of the turbines as compared with engines is not great. Comparing the *Antrim* and the *Londonderry*, it amounted to 1½ per cent. of the total cost of hull and machinery. In other words, for a speed of 19.5 knots the *Antrim* requires 38.6 tons of coal and the *Manxman* 35.0 tons, a saving of 9.3 per cent. The *Donegal* for a speed of 19.3 knots requires 38.7 tons and the *Manxman* 35.4 tons, a saving of 8.5 per cent.

THE ACADEMIC SIDE OF TECHNICAL TRAINING.

THE DEVELOPMENT OF INSTRUCTION IN ENGINEERING IN THE EDUCATIONAL INSTITUTIONS OF GREAT BRITAIN.

Dr. Alexander B. W. Kennedy—University College.

THERE will probably always be points of controversy as to the true relations between practical and academic training and instruction, especially when it is attempted to graft one department of education upon an institution originally devoted wholly to the other. The period included in the past thirty years, however, has witnessed a great change in educational ideas in these respects, and at no time has this progress been more clearly set forth than in the recent address of Dr. A. B. W. Kennedy, delivered before the Union Society at University College, London. Since Dr. Kennedy has been the active professor of the applied science of engineering at University College since 1875 he is qualified fully by experience to speak whereof he knows as regards matters of education, while his high standing as a practising engineer gives additional weight to his words.

Dr. Kennedy is an eloquent witness to the great work which was done in the early history of engineering education by one who is still regarded as a leader, the late Professor Rankine.

"Perhaps it may be said that Rankine was by nature rather a physicist dealing with engineering problems than an engineer dealing with engineering problems. But only those of us who have had occasion carefully to study his work from the point of view of trying to teach subjects similar to his, can ever know what an extraordinary physicist he was. Rankine was one of those men who were not only abreast of the scientific knowledge of his time, but in many ways greatly in advance of it; and many men with one-tenth of his originality, but perhaps with ten times his amount of self-assertion, have been able to obtain no mean repute as scientific thinkers."

As the demands of the time created an increasing interest in engineering education the question of the mechanical laboratory began to receive attention. Such laboratories had already been established on the Continent, but they were used primarily for original research and advanced experiments by teachers and scientific men, and not for the actual training and experimen-

tal practice of students. Professor Kennedy himself was instrumental in interesting some of the older engineers and business men in the matter, and the result was the beginning of the mechanical laboratory at University College.

"As to the general trend of our academic training, I think we engineers are entitled to say that it should be so arranged as best to train the best engineers. I put it in this way because I mean it to be understood that while on the one hand the *best* engineer is certainly not the man who knows his own business only and narrowly, on the other hand, I think we are entitled to demand that the engineer should not be looked upon as the mere by-product of the training, but as the chief result to which other things are to be subordinated.

"In saying this, however, I particularly do *not* mean that the academic training of engineers should be laid out exactly on superficially-utilitarian lines. The idea of giving a young man just as much mathematics, just as much physics, or just as much chemistry as the minimum that he can professionally require, is not only pernicious, but absolutely fallacious. There is no doubt that the only way of knowing a subject up to a certain point, in such a fashion that, up to that point, it can be thoroughly utilised, is to study the subject up to some point very much further advanced. It is not at all a valid objection to the teaching of any particular point in mathematics or physics that it is more complicated or more advanced than anything which the engineer will be likely to require in practice. That, in itself, is not an objection at all, because, as I have said, it is impossible really to master a scientific subject up to a certain—often very elementary—point without having at least a superficial knowledge of a much greater extent of the subject. But it is desirable—indeed, necessary from our point of view—that the advanced work in purely scientific subjects should be specially chosen so as best to deepen and make certain the knowledge of the earlier work."

In the teaching of applied science it is often necessary for the professor to give and for the student to receive certain statements upon authority, without any immediate proof being given. It is impossible for everything to be demonstrated upon the moment, and one of the important qualifications of a competent instructor is the ability to decide just how much he should give upon authority, and how much should be demonstrated. The student will find out for himself, later on in his work, the reasons for many things which he had to receive without proof.

"There is one matter in connection with the teaching both of mathematics and physics to engineering students which I think might well be emphasised more than is generally the case. Whether it is desirable that it should be emphasised in dealing with the general student, I do not venture to say. I mean, the point that the answer to any question can only be as accurate as the data of that question. For the ordinary examination question in mathematical physics it is necessary and unavoidable to presuppose certain data which in real life are absurd and impossible. In the ordinary everyday questions of engineering there is nothing more misleading than to take for granted the data of the examination paper; and a very great deal of the disrepute into which mathematical work had fallen at one time among engineers was due to the fact that, although the average student was able to use his methods rightly, he was unable to perceive whether they led him to a right result. I think it must be possible, even if it is not exactly easy, to point out to the student the extent to which the accuracy of his answers is influenced by the assumptions which he makes. It is, I am afraid, too often presumed that the method of working out the answer is the chief thing; perhaps it may be from some particular point of view. But for our purposes, foolish as it may sound, the method of working out the answer is only secondary; the answer itself is the chief thing, and we really *must* have that answer right when it finds itself translated into steel or stone. We would much sooner have a right answer got by an imperfect method than a wrong answer got by the best method in the world. And an answer may be wrong in two ways: it may be wrong because the data are in themselves wrong—that is to say, inapplicable to the particular case—or it may be wrong by being stated in a form much more accurate

than the real data will allow of; as when we find the indicated horse-power of engines given to six significant figures, when we know perfectly well that the fourth must always be doubtful. It would be most useful if our scientific professors would discuss these points with their students, and show them specially the extent to which the methods and theorems of the mathematician and the physicist may be properly applied, when the only data available for the problems are such as actually are found in practice. It is hardly fair to leave the engineering professor to tell his pupils, or to leave the engineer to tell his assistants, that the methods they are using are quite inapplicable, and the results which they are getting obviously inaccurate. This is in every way inadvisable, and may lead the otherwise guileless student to discount all his teachers instead of only one. Every scientific experimenter knows that it is often the most difficult part of his work to say how alterations in data or want of knowledge of accuracy in data may affect the result; and I should like much to see this matter systematically dealt with by the teachers who have actually to do with the scientific or theoretical treatment of the questions concerned."

In connection with advances in technical education Dr. Kennedy makes a suggestion which has already been carried out to some extent in connection with the work of the engineering schools in the United States, that is, the association of active members of the engineering profession in the work by means of addresses, lectures, and instruction, thus bringing the students into closer contact with current work than is otherwise practicable.

"I should much like to see the development of some such connection between old and distinguished students of a college, who become later on older and more distinguished engineers, and the college at which they have studied, or some other college, as exists in the similar case of the medical profession. I do not mean simply, or indeed at all, that, for example, University College should ask senior engineers in the country, or in Westminster, to give occasional lectures to their students on special subjects. I do not say that such an arrangement may not be useful as an accidental or occasional thing; but I mean much more than this. The senior engineer may have a very large experience, and have carried out a great deal of work. But he is probably not in touch with the college, or with academic work of any sort, nor in touch with students at all; and, therefore, while he knows his subject, he may be a very unsatisfactory teacher. There are two difficulties in an older man going straight from business to lecture. One is that, being out of touch with students, he does not understand the difficulties which present themselves to young men, and which have so long ceased to be difficulties to himself, that he has even forgotten their existence. Then, secondly, having been for many years accustomed to look at his professional work entirely from the non-academic side, he really knows too much to be able to lecture about anything. He would be too apt to overload his lectures with masses of, no doubt, very important statements; which would not be appreciated by men in the student stage; and which by themselves would also probably involve difficulties of apprehension which would make their mere statement to the student useless, a condition of affairs exactly comparable with that which I have already deprecated on the scientific side of the work. My suggestion is, that to get the full benefit from its best pupils a college should, if possible, keep in touch with them after they have left it. A few years after they have left college, and when they have fairly got into the swim of professional work—but before they have so must lost touch with the difficulties of their college days that they no longer appreciate the student's point of view—they might be made to help in teaching by giving lectures on the special branches of engineering with which they were specially and actively familiar. They should do it before they have forgotten what they formerly learnt, or have had it driven out of their heads by the pressure of other ideas, and while college methods and points of view are still familiar. They would be men still making their way in their profession; still, let us hope, full of enthusiasm for their work; and certainly they would be daily finding out the differences between actual and academic problems."

ALLOYS OF COPPER.

A PRACTICAL AND SCIENTIFIC STUDY OF THE PROPERTIES OF BRONZES AND BRASSES AND SPECIAL COPPER ALLOYS.

Leon Guillet—Le Génie Civil.

FROM the earliest times the metal copper and its alloys have been used by mankind, and at the present time they may be considered as second in importance only to the iron-carbon alloys. For this reason the systematic study of bronzes and brasses recently made by the well-known metallurgist, M. Leon Guillet, and published serially in the pages of *Le Génie Civil,* is of direct engineering value, exhibiting, as it does, a résumé of the present state of knowledge concerning this important group of materials of construction.

M. Guillet divides the industrial copper alloys into six groups, the first consisting of the ordinary copper-tin bronzes; the second the special bronzes, containing in addition to the tin certain proportions of lead, zinc, phosphorus, manganese, etc. The third group includes the common brasses, containing copper and zinc only; followed by the fourth group of special brasses, used for naval purposes. The fifth group contains the aluminum bronzes, alloys of copper and aluminum; while the sixth group covers the minor copper-alloys, such as copper-phosphorus, copper-silicon, copper-manganese, etc.

The theory of these various alloys is discussed at length, using the researches of Le Chatelier, of Roberts-Austen and Stansfield, and of Heycock and Neville, together with those of the author himself, the subject being examined in the light of the methods of metallography and of photomicrography, but for this portion of the paper the reader is referred to the original and the accompanying micro-photographs. M. Guillet, however, devotes the greater portion of his articles to the practical and industrial side of the subject, and of this portion we make some abstract and review.

The results obtained by mechanical tests of the various alloys have not always been consistent, and this may be partially attributed to the fact that the rapidity of cooling has a marked influence upon the behavious of alloys containing a large proportion of copper. Messrs. Heycock and Neville have plotted cooling curves showing the successive phases for copper-tin alloys containing about 90 per cent. of copper and 10 per cent. of tin, this corresponding to the so-called gun-metal, formerly used for artillery. These investigations have been carried further by M. Guillet, and he shows, broadly, that for alloys containing more than 92 per cent. of copper the resistance to rupture is slightly increased by tempering at a low temperature, from 400 to 600 degrees C., a corresponding variation appearing in the elongation. For alloys containing less than 92 per cent. of copper the breaking strength and the elongation increases in a marked degree for a tempering from 500 degrees C. In any case the maximum resistance is attained by tempering at 600 degrees C. The maximum elongation, however, varies with the composition of the alloy. Thus, for a bronze containing copper 91, tin 19, the greatest elongation appears when tempered at 800 degrees, while the alloy copper 79, tin 21, is most ductile when tempered at 600 degrees C.

In practical work bronzes are employed principally for two different classes of service: either to resist friction, as in bearings, or to resist other stresses, as in gear wheels, and the like. Bronzes for bearings vary in composition from copper 81 to 87, tin 19 to 13, the lower copper content giving the harder bronze. In practice a small percentage of zinc is usually present, and for railway car bearings an alloy of copper 75, tin 22, zinc 8, is sometimes employed.

The harder bronzes are principally used for bearings in which considerable shocks are to be resisted, as in the case of the connecting-rod boxes of explosion motors and the like, while the softer alloys are suitable for bearings having continuous and uniform circular friction.

For gear wheels and similar work the phosphor-bronze alloys are generally employed, this and some other alloys coming

under the second group of special bronzes. The phosphorus acts, not by its presence as a constituent of the alloy, but by its deoxidizing effect reducing the oxides of copper and tin, and removing especially the very injurious cuprous oxide. The phosphorus is not added directly to the molten bronze, but previously prepared as phosphor-copper or phosphor-tin, containing from 8 to 10 per cent. of phosphorus, and this is added to the melted bronze in such quantity as to produce the required percentage. In the finished bronze the phosphorus often appears only in traces, having produced its effect by reducing the injurious oxides. Bronze for wire contains about 95 per cent. of copper and 5 per cent. of tin, with 0.1 of phosphorus, while for gear wheels and similar service the proportions are copper 90, tin 10 per cent., only traces of phosphorus appearing.

Bronzes containing lead are much used for bearings. In such cases the lead does not alloy directly with the bronze, but remains in separate particles, as may readily be seen by the microscope. The function of the lead is to increase the plasticity of the alloy, and this effect is produced to a marked degree. The principal difficulty in the use of lead for this purpose is found in the tendency to the separation of the lead by liquidation, the lead having a much lower solidifying point than the bronze, so that even if the metal is not poured until it has acquired a pasty consistency there is a tendency for the heavy particles to sink in the mass. It is very difficult to be assured of an equal distribution of the lead in such alloys, and the exact composition of the metal at the rubbing surface is necessarily uncertain.

Bronzes containing a small percentage of manganese are used for special purposes, the effect of the manganese being to increase the resistance and the ductility. It has been assumed that the manganese acts as a deoxidizing agent, somewhat in the same manner as phosphorus, but M. Guillet believe that this is not the case. The proportion of manganese should not exceed 2 per cent. or the the resistance of the alloy will be impaired, and the commercial bronzes of this type contain about 1 per cent. of manganese.

Bronzes containing silicon have been made to advantage, the silicon appearing to act as a deoxidizer in practically the same manner as phosphorus. A silicon-copper, containing from 10 to 20 per cent. of silicon is made, and this is added to the bronze in such proportions as are found sufficient to remove the oxides, leaving barely a trace of silicon in the alloy.

The brasses, or alloys of copper and zinc, form an important class of materials of engineering. In studying these, M. Guillet follows the same plan of examining the cooling curves and the micro-photographs of the more important alloys, and then takes up the industrial applications.

Ordinary brasses contain about 60 parts of copper to 40 of zinc, the proportions varying according to the uses to which the metal is to be put. If the proportion of copper is greater than 60 per cent. the brass can be rolled or drawn cold, but for a copper content from 55 to 60 per cent. the alloy can only be worked hot.

The principal precautions to be taken in the preparation of a brass are those to minimize the loss of zinc by volatilization. The copper is melted first, and the zinc, which has been previously heated, is quickly added, oxidation being reduced as much as possible by covering the surface of the molten metal with powdered charcoal, or even with a flux of borax. The metal should be poured into the ingot moulds with great care: if the temperature is too high the alloy will be porous, while if it is too cool the product will not be homogeneous.

In the process of hot rolling a bar may be subjected to a considerable reduction at the first pass, and then, after reheating it can be brought to the finished size. This method, however, produces a metal of coarse grain, with greater hardening than is produced by careful cold rolling. The annealing of brass should be effected at a temperature of 550 to 600 degrees C. If the temperature falls below 550 degrees the annealing will be but partially effected, a portion of the hardening due to the rolling remaining, while at a higher temperature than 600 degrees the metal is apt to become burnt.

M. Guillet gives the composition and properties of a number of brasses, some of the most important may be noted. Thus

brass for cartridge shells contains from 67 to 72 per cent. of copper, while for making brass screws the alloy is 60 copper, 40 zinc. Common yellow brass for castings generally contains 2/3 copper to 1/3 of zinc, but metal for this purpose often includes scrap of unknown composition, introducing lead, tin, and iron into the product. The best metal for drawing into wire contains about 70 copper, 30 zinc, and especial care should be taken to insure the absence of lead.

So-called brazing metal, or brass solder, for making joints in brass, iron, or steel, is of interest, and in this case the fusibility of the alloy is of importance. A common soldering brass is made of copper 34, zinc 66, but this is not very strong. Better solders are of more complex composition, such as: copper 44, zinc 50, tin 4, lead 2. For brazing iron or steel a good alloy is: copper 70, zinc 30, or copper 67, zinc 33, but these require a much higher temperature for their fusion.

The special brasses include those containing lead, tin, manganese, aluminum, etc.

Nearly all brasses contain a small proportion of lead, introduced with the scrap metal, but the amount should not be permitted to exceed 1 to 2 per cent. Ordinary brasses will be found to contain 0.4 to 0.6 per cent., while as much as 0.5 per cent. may be intentionally added to increase the facility of moulding unless especial strength is wanted in the product.

The addition of tin produces a marked modification in the properties of the alloy, raising the ultimate strength and the elastic limit, and reducing the elongation and the contraction of area. It also increases the hardness, and especially improves the resistance to the corrosive action of sea water. A special brass for naval use contains: copper 60 to 62, zinc 39 to 37, tin 1.5.

Manganese brass, originally made by Parsons in 1876, is a valuable alloy, containing from 2 to 4 per cent. of manganese. The effect of the manganese is to increase the ultimate resistance and the elastic limit, without producing increased brittleness. Brass containing manganese is extensively used for screw propellers, rudders, and other important marine castings.

Aluminum brass is another alloy, the presence of the aluminum permitting a brass of 70 copper, 30 zinc, to be readily forged while hot.

M. Guillet devotes one paper to the consideration of the special alloys of copper with metals other than tin or zinc, the most important of these being the aluminum bronzes and the manganese bronzes. The aluminum bronzes are of two extreme classes; the aluminum bronze strictly so-called, containing about 90 copper and 10 aluminum, of high resistance and ductility; and the alloy containing a small percentage of copper, and generally sold under the name of aluminum, this being used for certain parts of automobiles on account of its lightness.

Manganese bronze, consisting of copper 95.5, manganese 4.5, is especially valuable because of its resistance to the corrosive action of vapors and liquids, being employed for various purposes in chemical works, and the like.

Space prevents a more detailed consideration of the alloys discussed by M. Guillet, but his articles form a valuable contribution of mechanical technology, and contain much useful special information.

LEAKAGE OF STEAM ENGINE VALVES

THE INFLUENCE OF VALVE-LEAKAGE UPON THE PERFORMANCE AND DESIGN OF STEAM ENGINES.

Professor R. H. Smith—The Engineer.

RECENT reports of tests and investigations upon steam-engine performance have called attention to the fact that the valves by which the admission and exhaust of the steam from the cylinder are controlled are by no means always as tight as has been supposed. It has even been maintained by some investigators that a considerable proportion of the loss hitherto supposed to be caused by internal condensation may be due to the leakage of the steam past valves supposed to be tight, but in reality quite leaky. In a discussion of the recent report of the Steam Engine Re-

search Committee of the Institution of Mechanical Engineers, published in the *Engineer*, Professor R. H. Smith examines some of the conditions surrounding the operation of steam-engine valves, and his discussion will be found both interesting and profitable.

Taking up the question of the form of the valve with respect to its possible tightness, Professor Smith shows that a study of leakage should be made in a thoroughly scientific manner.

"In order to establish the laws of leakage through a sliding joint, flat slides are, no doubt, the simplest, and, therefore, the best forms to experiment with; but with drop valves one has to do with a fixed and not a sliding joint. If one wants to investigate leakage through a sliding joint, surely the scientific method is to use a slide covering only one port, namely, the exhaust port; to arrange means whereby the mean lap may be varied without altering the fit between the sliding faces; to arrange means of varying the mechanical pressure between the faces independently of the pressure which produces leakage; to adopt means of varying the fit between faces independent of all other change, and of varying the temperatures as well as the pressures effective in producing warpage of either face. So far as influence of fit is concerned, in order to obtain exact quantitative results, of course cylindric or piston slides offer superior facilities for experimentation, but the results cannot have much significance as regards flat slide leakage.

"Workshop experience with manifold forms of valve has long since demonstrated that the true secret of steam tightness lies in the design of valve and seat together in regard to mass, shape, and surface exposures to live and exhaust steam respectively such as, while it leaves both valve and seat the greatest practicable freedom to change in size under variations of temperature and pressure, will also keep both of unchanged shape. The old pattern of flat slide valve, designed without this modern knowledge of the real conditions of success, cannot yield results of important significance in steam engine research."

There seems to be little doubt that drop valves, or poppet valves, as they have been called, are preferable either to flat slides or to Corliss valves, for engines of modern design. Drop valves have been employed, among other reasons, to obtain quick cut-off, and some of the most efficient engines of Continental builders have been designed with such valves, but they have other advantages. They can be made tight, and when the valve and its seat are properly designed, they will remain tight, even when used with highly superheated steam, a condition which must be accepted as necessary if the highest economy is to be obtained. In fact it is well recognized that the drop valve is the only reliable type for use with internal-combustion engines, in which the temperatures far exceed those of the highest superheated steam.

"As regards leakage, a distinction should be sharply drawn between leakage between a pair of very narrow bearing surfaces, such as those of drop valves, and that between wide lap surfaces, such as those in flat, piston, and Corliss slides. In the former case the leakage approximates to the flow through a pin-prick in a thin plate, and there is no reason to suppose that the passage between the metal surfaces compels condensation of steam in any degree greater than in the small orifice in the thin plate. If the bearing edge has more than a certain width, there may be a simmering leak, which means that the leaking material issues as liquid, and boils immediately it escapes into atmospheric pressure. But if it were a sharp knife-edge there would be a blow through of steam alone if only steam arrived at the high-pressure side of the joint.

"It would be interesting to discover the limit of breadth that separates this kind of leak from that through wide lapping surfaces. Here the high conductivity of the metal promotes a more or less rapid flow of heat towards its cooler parts; this flow keeps the metal surface which is in contact with the steam at a lower temperature than the layer of steam within its radius of direct thermal influence; and consequently heat flows from the steam to the metal, or rather, to both the opposite metal faces. There is an extremely thin layer of steam to give up heat; its latent vapour heat is soon exhausted, and it is liquefied before it has penetrated far beyond the

in-edge of the lap joint. Beyond this—that is, through nearly the whole length of the leakage passage—the leak is a flow of liquid. It cannot be too constantly borne in mind that a flow through a narrow channel in which the drop of pressure is spent in overcoming viscous and frictional resistances is a purely volumetric phenomenon; by which is meant that for given drop of pressure per inch length, given cross-sectional dimensions of the channel, and given viscosity and friction coefficients, the volume of flow per second will be the same, whatever be the density of the fluid passing. As water is a thousand times more dense than steam, a thousand times as great a weight of water would leak per second as of steam if there were no difference between the friction and viscosity coefficients and no difference between the pressure gradients across the leak with water and steam. In a water leak the pressure gradient is almost certainly uniform except for variation in the closeness of the two metal surfaces, while in a perfectly dry steam leak, because of the expansive character of the fluid, the pressure gradient will not be uniform, and the whole of it will not be spent on friction and viscosity, part of it being spent on mass acceleration. Thus the two cases differ largely, beyond the limits of mere difference of friction and viscosity coefficients; but the excess of water density is so enormous that wherever the leak passage is long enough to produce sufficient delay to induce liquefaction of the steam, the rate of leakage measured by weight must be much greater than in dry steam leakage. This excess will evidently become more pronounced if at entrance into the leak the steam be already wet."

There is one lesson which may be drawn from the study of valve leakage which has not been brought out as fully as it might be, and that is the great advantage of a steam engine which has no valves, and in which the steam passes through in a continuous flow, as in the case of the steam turbine. Apart from the gain in construction, this question of the elimination of valves, which, even if tight when new may become leaky after a short period of service, is well worth considering, and it is not the least of the numerous advantages of the turbine type of steam engine.

CARBON-FILAMENT INCANDESCENT LAMPS.

IMPROVEMENTS IN THE PREPARATION OF CARBON FILAMENTS FOR INCANDESCENT ELECTRIC LAMPS.

John W. Howell—American Institute of Electrical Engineers.

WE have reviewed recently in these pages the developments which have been made in the use of metallic filaments for incandescent electric lamps, and the work of Feuerlein and Von Bolton with the tantalum lamp, and of Auer von Welsbach with the osmium filament, indicates that the carbon filament must be improved as well if it is to hold its own. At the recent meeting of the American Institute of Electrical Engineers Mr. John W. Howell described some improvements in carbon filaments which may go far to enable the earlier form of lamp to maintain its position in the domain of incandescent electric lighting, and some account of the results will be found of interest.

"In briefest outline, the new characteristics of the filament may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. The value of the product is determined by the conditions under which the high temperatures are applied.

"It is well known that an ordinary incandescent filament in an evacuated lamp may be heated to excessive temperatures by the application of high current without producing any beneficial change in the filament. To produce the effects described in this paper the heat is externally applied to treated filaments at atmospheric pressures. The simple application of the highest attainable temperatures to the plain carbonized cellulose fiber, i. e., the so-called 'filament base,' is also incapable of producing any considerable change in the filament. This high temperature treatment of the base is, however, a beneficial step in the process here described.

"Before describing the new process, it may be well to recall the steps by which the standard filaments are made. A solution of cellulose is squirted through a die into a liquid that hardens the cellulose. The resulting fiber is dried, then shaped into the desired form for the finished filament and heated in a muffle until carbonized. In this process the highest temperature of a gas-furnace is employed. The into the desired form for the finished filament.' The base filaments are usually separately heated by a current passed through them while they are surrounded by an atmosphere of hydrocarbon vapor, and in this way a coat or shell of graphite is deposited upon them. They are then said to be treated filaments. The best quality of standard carbon incandescent lamps of today owe their superiority to the use of treated filaments.

"In attempting to graphitize carbon filaments it was discovered that treated filaments undergo very remarkable changes when subjected to the highest possible temperature of an electric resistance furnace. The furnace consisted of a carbon tube, held at the ends by large water-cooled copper clamps; the tube was imbedded in powdered carbon to prevent its combustion. The filaments were packed in small, cylindrical carbon boxes, which were fed into the heated tube. The temperature was usually between 3,000 and 3,700° C. Under such firing the ordinary treated filament changes in appearance; its graphite coating looks as though it had been melted, and its specific resistance is greatly reduced. The resistance of one of these filaments, measured at ordinary temperature, may be reduced as much as 80 per cent. by the firing."

The results of tests made by using such filaments in incandescent lamps are given by Mr. Howell in the form of resistance-temperature curves, enabling comparisons to be made between the treated and the ordinary filaments.

There is every reason to believe that filaments prepared according to the process described by Mr. Howell will have a longer life and give a higher degree of efficiency than the untreated filaments. At the present time the most effective carbon filament in general use operates at 3.1 watts per candle, and under accurate test conditions it gives a useful life of about 500 hours, to 80 per cent. of its initial candle power. With the new filament a useful life of about the same length is obtained, while the consumption of energy is only about 2.5 watts per candle, which approaches the performance of the tantalum and the osmium lamps.

"The appearance of a filament fired both before and after treating is very different from that of one fired after treating only. The former has a slightly pebbled appearance, as seen through a microscope, and a rather dull-gray color. The single-fired treated filament is generally very much blistered, many blisters extending outward a distance greater than the diameter of the filament. These blisters indicate an outflow of gas from the base when the shell was in a soft condition. The surface of the filaments is highly lustrous.

"The specific resistance of the highly heated coating has been found to be as low as 0.00006 ohms per cubic centimeter, which is very much lower than the specific resistance of any other known form of carbon or graphite. Its specific gravity is also much higher than it was before heating. Its changed nature is also indicated by its toughness and flexibility. The coating of a double-fired filament may be pulled off in short tubular sections, which if pressed flat, will spring back to their original form when the pressure is removed. The same coating before being fired is comparatively brittle, and will break with very little pressure. On account of the positive resistance curve and physical characteristics of these filaments, they have been given the name 'metallized filaments.'

"The treated coating on filaments, even before firing, is graphite, as determined by the chemical test established by Berthelot—the production of graphite acid (a yellow insoluble substance) when treated with a mixture of anhydrous nitric acid and potassium chlorate. Ordinary carbon is dissolved by these reagents. The coating on the treated filament has also the greasy feel of graphite, and gives the characteristic mark of graphite on white paper. After being heated to high temperatures in the electric resistance furnace these characteristics continue and the chemical ac-

tion becomes very much more marked.

"Metallized filaments blacken the lamp-bulb very much less than ordinary filaments. This may be due to the removal from the former of practically all the mineral ash and other impurities, or it may be due to the changed character of the carbon itself.

"Bamboo, coated by dipping in a solution of asphalt, is altered by firing, the coating changing to graphite and giving the characteristic positive curve. Silk dipped in a sugar solution also gives the same result.

"The base of a metallized filament, from which the treated coating has been removed, when mounted in a lamp has been found to give the resistance curve of a fired base. Pieces of the coating, about 1.5 in. long, mounted in lamps, have been found to give the strongly positive resistance curve that is characteristic of the metallized filament. These observations show that the change is practically all in the treated coating and not at all in the base.

"Metallized filaments, as above described, are much more stable at high temperatures than ordinary carbon filaments."

The recent development of interest in the incandescent electric lamp is most encouraging, and the number of candidates in the field, and the fact that they are being developed by competing manufacturers, adds to the possibilities, and the consumer should obtain some portion of the benefit. The Nernst lamp appears to be in a fair way to fill the demand for a lamp of intermediate power between the carbon glow lamp and the arc lamp. The tantalum lamp has shown an efficiency of about 2 watts per candle, and the osmium lamp claims a consumption of about 1.5 watts. If the new filament of carbon does not cost too much to manufacture, and can be produced with a fair degree of uniformity it will be able to meet the metal filaments very closely, and it may be improved so as to compare with them in life as well as in efficiency.

THE TRAFFIC PROBLEM IN LONDON.

PROPOSED METHODS FOR IMPROVEMENT IN LOCOMOTION AND TRANSPORT CONDITIONS IN THE STREETS OF LONDON.

Report of the Royal Commission.

IT has long been recognized that some improvement in traffic conditions in London was necessary, and more than two years ago a Royal Commission was appointed to investigate and report upon this important question. The subject is one which interests not London alone, but concerns also many other large cities suffering from the congestion which forms such a difficult problem in municipal affairs. The report of the Commission has now been made public, and some abstract of the information and suggestions will be found of interest and value, not only at home, but in many other places.

Like nearly all large cities, London consists broadly of a business and commercial quarter, and of a residence district or district with a daily flowing and ebbing tide of humanity, and this tide is obliged, for a portion of its course, at least, to pass through streets originally designed to meet the conditions of several centuries back. After the great fire of 1666 Sir Christopher Wren, with a foresight most unusual, suggested that the necessity for rebuilding the burned district be made occasion for widening streets, straightening crooked ways, and providing broadly for immediate and future growth, and his plans, which are yet in existence, would have been the basis of an immense improvement, could they have been carried out at that time. Difficulties in connection with property lines, together with the general lack of united effort at the time, caused Wren's invaluable suggestions to be ignored, and the city was rebuilt on practically the original lines; and the result is that London is attempting to conduct the business of the twentieth century upon thoroughfares which were insufficient for the traffic of the seventeenth century.

It is true that successive attempts have been made to improve the traffic conditions, but such improvements have usually been made under the pressure of excessive congestion, and not with a regard for fu-

ture demands, and hence the relief has been but temporary. In fact it has been asserted, and with much force, that all attempts to provide improved transport facilities have only resulted in creating an increased congestion, by reason of the greater number of people brought into the metropolis. The replacement of the stage coaches by steam railways was followed by a rapid increase in the population of London. When underground transport was begun it was found that the crowding of the streets was not perceptibly diminished, and at the present time the more tubes there are the more seem to be demanded.

The omnibus has done its work well in the past, and either horse-drawn or mechanically propelled, it will doubtless long continue to be used, but its limitations are those of the streets upon which it must travel. Electric trams have been extensively employed in other cities, notably in the United States, where the transport problem in large cities is almost as pressing as in London, but tramcars are almost as dependent upon street capacity as are omnibuses, while, as Col. Crompton has well pointed out, the omnibus has an "overtaking power" which the tram-car lacks.

It is evident that means of relief cannot be the same for all cities, and that geographical conditions have an important influence upon the methods which can be considered for any given case. The Chairman of the Commission, Sir D. M. Barbour, and a number of the members, visited the United States, and examined the systems in use in New York, Philadelphia, and Boston. Of these cities Philadelphia most nearly resembles London in general conditions, while New York is the most remote, consisting, as it does, of a tongue of land extending between two wide rivers, the business district being concentrated in the lower portion and the residence section occupying the balance, with wide avenues running lengthwise for the greater portion of the distance. For such a situation it is entirely practicable to provide longitudinal arterial transport systems, both overhead and underground, but the conditions in London are so different as to render comparison impracticable.

The inquiries of the Commission showed that the total number of rides per capita for London, with its population of 6½ millions, is about 200, not including trunk-line service, while in Berlin the number is 270, and in New York 300. The only way in which provision can be made for the increasing demand is by the opening of new streets and the provision of new railways. Following out this idea, and being governed, doubtless, by the shape of Greater London, the Commission proposes, as the principal basis of relief, the opening of two main avenues, one east and west, connecting Bayswater-road with Whitechapel, a distance of 4¾ miles, and the other extending north and south a distance of 4½ miles, connecting Holloway with the Elephant and Castle. The roads are to be 140 feet in width between the house lines, and provided with four lines of surface tramways, and four lines of subway track, giving both express and local service.

The cost of such a work, taking into account property values in London, would be from £25,000,000 to £30,000,000, but with the outlay there would also be brought into existence the immense income producing elements of the surface and underground railways, properties which would seem more than capable of earning the interest on the cost of the entire improvements. The report also includes recommendations as to the widening of existing streets and other improvements, which, if all carried out, would practically result in a rebuilding of many portions of the metropolis. This undertaking is of such magnitude that its execution must extend over a long period of time, and since improvements must be necessarily made in the course of time it is far better to have them executed in accordance with a general and systematic plan than to conduct a number of independently conceived works.

Apart from any plans for the amelioration of traffic conditions, however, there is much relief to be obtained by the improvement in general facilities for communication. There is no doubt that a highly efficient telephone system would do as much to relieve traffic conditions in London as it has already done in other places, and much of the crowding of the streets of business quarters would be avoided if it were rendered unnecessary to hold per-

sonal interviews for all communications which could be made by telephone. The time gained by a prompt and efficient telephone system is thus a double gain, and there is no necessity for delay in making this improvement. The use of pneumatic dispatch tubes, both for parcels and for local letters, is another means of partial relief, and in general the immediate remedy for congestion appears to be the provision of such methods as can be devised for diminishing the necessity for running about the streets.

There is no permanent remedy in sight, and none can be expected, since the principle that "facilities create traffic" holds as good in the streets of a great city as it does upon the great highways of commerce, but existing conditions can be improved, by some of the methods indicated.

DIRIGIBLE-BALLOON CONSTRUCTION.

PRACTICAL EXPERIENCE IN THE CONSTRUCTION AND OPERATION OF THE LEBAUDY DIRIGIBLE BALLOONS.

H. Julliot—Société des Ingénieurs Civils de France.

IT is interesting evidence that efforts to construct machines for the navigation of the air have passed into the domain of practical engineering, when papers upon the once derided subject are seriously presented and discussed before engineering societies of the highest reputation. This is especially significant when such papers represent accounts of work actually accomplished, and are not confined solely to academic discussions of unproved theories.

While it is believed by many eminent engineers that final success will be attained in aerial navigation by an apparatus which is itself heavier than the air, it is none the less realized that in the present state of the art some form of dirigible balloon must be employed for actual experimental operations of any magnitude. From the experiments of Renard down to the latest trials of the recent dirigibles, public attention has been directed to the possibility of employing some form of gas bag, sustaining a car containing a light motor operating a screw propeller, and while it is generally admitted that such a machine is really only a transitional device between the drifting balloon and the wholly controlled and self-sustaining aeroplane, it is certainly the machine of the present, and as such, entitled to respectful consideration.

In a paper recently presented before the Société des Ingénieurs Civils de France by M. H. Julliot, and published in the *Mémoires* of the society, there is given a very complete account of the numerous experiments which have been made since 1899, under the auspices of MM. Paul and Pierre Lebaudy, with the dirigible balloon which bears their name. Such an account, prepared by the engineer who has been most intimately connected with the work, and by whom the various parts have been designed, forms a most valuable contribution to the science of aeronautics, and some abstract and review of the paper is here given.

There is no doubt that the development of the dirigible balloon has been largely due to the progress in other departments of industry. Thus, M. Julliot refers especially to the value of the 12 per cent. nickel-steel alloy, which, after careful annealing, has a tensile strength of 100 kilogrammes per square millimetre, or about 142,000 pounds per square inch, showing at the same time an elongation under test of 18 per cent. This material, when drawn into tubes of 20 to 40 millimetres in diameter, with thicknesses ranging from 0.6 to 2 millimetres, permits the construction of a framework of considerable strength and extreme lightness.

The development of the automobile industry has also rendered it possible to produce motors of high power and extremely light weight and this has also contributed to the development of the dirigible balloon. Thus it has been found possible to make an operative motor weighing not more than 10 kilogrammes per poncelet, or only about 7½ kilogrammes per horse power, and a consumption of only 425 grammes of essence per poncelet (315 grammes per horse power), so that the increased strength of the structure and the

decreased weight of the motor united to aid the designer very materially in his difficult work.

M. Julliot emphasises the necessity of using pure hydrogen gas as the substance for filling the balloon, since it gives an ascensional force of 60 per cent. greater than is attainable with ordinary illuminating gas. In actual practice the gas is produced by the reaction of iron with ordinary sulphuric acid, the product being purified by washing to remove any acid, and by treatment with a mixture of sawdust, lime, and sulphate of iron, to absorb the hydrogen sulphide, both of these impurities being injurious to the fabric of the balloon. This is followed by the passage of the gas through cylinders containing a mixture of fossil meal and permanganate of lime, this being for the absorption of the hydrogen arseniates and phosphates, together with the carburets which would increase the specific gravity of the gas. Finally the gas is passed through caustic soda, to remove any trace of carbonic acid, and it is only after such a course of purification that it is held to be suitable for the purpose of filling the balloon. In this purified state the gas is possessed of so little odor that it has been found necessary to add a perfume in the form of muronine, in order to enable leaks to be detected by the sense of smell.

Pure hydrogen gas, containing about 2 per cent. of oxygen, has been prepared by the electrolytic decomposition of water, and this gas, compressed in cylinders to pressures of 100 to 150 atmospheres, has been found especially convenient for refilling the balloon at distant points, since the gas can be shipped by rail. The weight of the containers is such that they cannot be carried to advantage in the machine, but they have been successfully used at points of descent. Hereafter it may be found practical to carry light reservoirs of liquid hydrogen, and replenish the balloon en route, but the cost has rendered this plan impracticable for the present.

A most important element in the success of the apparatus is the balloon itself, since it must be made as tight as possible, and be held rigidly to its predetermined form, while being at the same time of minimum weight. The most available material for the balloon itself has been found to be a cotton fabric coated with india rubber, and the final construction adopted for the Lebaudy machine consists of two layers of cotton fabric, alternating with layers of vulcanized rubber, this weighing 330 grammes per superficial metre. If a larger balloon should be constructed in the future there yet remains silk as a still stronger substance. The internal layer of vulcanized rubber protects the fabric from the action of the gas, and by making the material of a yellow color the rubber is protected from the actinic effects of sunlight.

The general form of the Lebaudy balloon is that indicated by Renard many years before, being in the shape of a cigar, with the greatest diameter somewhat forward of the centre, and with the rear rounded off, while the front end forms a sharp point. Experience has shown the impracticability of stiffening such an envelope by any internal or external metallic bracing, and the shape of the balloon itself, and the pressure upon the internal ballonet must be relied upon for this purpose. The Lebaudy machine of 1904 has a balloon of a total length of 57.75 metres, or 189.5 feet, and a maximum diameter of 9.80 metres, or 32.15 feet, with a volume of 2,666 cubic metres, giving a sustaining capacity of a little more than 3,000 kilogrammes, or about three tons This is sufficient to lift all the structure and machinery, together with four persons, fuel enough for seven hours' operation, and 300 to 350 kilogrammes of ballast.

M. Julliot describes in detail the light, but rigid tubular frame work below the balloon, carrying the car, the motor and the propelling machinery. The motor of the 1904 Lebaudy is a 40 horse power Mercedes, with four, four-cycle cylinders, running at a normal speed of 1,000 revolutions, and capable of regulation from 250 to 1,200 revolutions per minute. The crank shaft of the engine is placed across the axial line of the balloon, and connected by mitre gearing to the two propeller shafts, there being twin propellers, running at the same speed as the motor. The outside diameter of the two-bladed propellers is 2.44 metres, the inner ring to which the blades are attached being 0.5 metre, and it has been found that better results are obtained with propellers of moderate size, running at a

high speed than with larger wheels, moving more slowly.

This machine has made a large number of trips in all kinds of weather, and the details of some of these excursions are given in the paper of M. Julliot, showing that such an apparatus can maintain a satisfactory equilibrium, and can be well controlled, even in windy weather; the results, so far as wind is concerned, depending principally upon the power of the motor. Much valuable experience has been undoubtedly gained, and even though one may very properly maintain that such machines do not represent the ultimate type of flying machine, they undoubtedly give many opportunities for investigation in the great problem of aerial navigation.

ELECTRICITY IN COAST DEFENSE.

A SCHOOL WHERE OFFICERS OF THE ARTILLERY OF THE UNITED STATES ARMY ARE TAUGHT HOW TO USE ELECTRICITY IN WAR.

Electrical Review.

THE development of the war between Russia and Japan has emphasized the importance of the protection of harbors by properly arranged submarine mines, and as it is always important to prepare for war in time of peace, so it is interesting to examine the extent to which other nations have availed themselves of the latest progress in science for the defense of its coasts and seaports. In a recent issue of the *Electrical Review* (*New York*), there is given an account of the work at Fort Totten, where the artillery officers of the United States army are instructed in the use of the latest methods of defense by the use of mines and of electrical control of high explosives.

The coast of a country is protected from foreign attack in two different ways: first, by the navy; second, by the coast defenses erected to protect each separate harbor.

"The responsibility for the coast defenses rests with the artillery. The military engineers may plan and build a fortress, but the artillery must hold it, defend it, and beat off hostile attacks. In the modern way of doing this electricity is becoming one of the most important factors.

"There are two ways of defending a harbor which comes under the artillery's care. The one is by mining, the other by gun fire. Mines may be of several kinds. For defending a harbor they are generally anchored in known positions. In general, they consist of large pressed steel vessels having either a spherical or cylindrical form. Within them is placed a charge of a high explosive, which, in some classes of mines, would be detonated by coming in contact with a vessel, or which might be harmless until fired by means of an electric current controlled from the shore. The two types may be combined so that the mine may be fired either by contact or from the land.

"Those mines which are fired electrically necessarily call for careful work, not only in arranging the firing device, but in connecting this to the firing station on land by means of a submarine cable. These cables are led to a controlling switchboard placed in a building well out of danger from hostile fire, and here is stationed the officer, who, at a given signal, fires the designated mine. The switchboard to which the mine cables run provides not only for firing the mine, but for testing its condition at any time. The power supply must be always ready for use at a moment's call.

"There are several ways by which the signal to fire a mine may be given. The vessel itself, by striking the mine, may give the alarm which leads to its destruction, or the method known as judgment firing may be adopted. The simplest way, of course, would be to use contact mines which would explode as soon as struck, but the objection to these is that they are nearly as dangerous to friends as to foes. Those mines which can be fired from the shore may be perfectly harmless until the firing current is sent through them. They can be set off even though the hostile ship be not in contact with them, and thus disable it. In the method known as judgment firing a range-finder is placed in a fire-control station at some point which commands the waters which have been

mined. The position of every mine is carefully plotted on a chart, so that if the location of a hostile vessel be known, it will at once be seen whether she is in proximity to a mine. Upon the approach of a vessel she is watched by the range-finder, who not only determines her direction from the station and her distance, but the course she is following and her speed. He plots this on the chart and estimates which mine the vessel is approaching and the exact time when she will reach it. Allowing a definite time for transmitting the order by means of a telephone and for the officer at the other end to close the switch, he gives a signal when he thinks the vessel will be over the mine by the time it is fired. Naturally, operations of this kind can only be conducted satisfactorily and surely after a great deal of practice. Not only must the officers and men be drilled thoroughly in the work, but they must be entirely familiar with the system and with all the apparatus. Then, too, the handling of the electrical devices employed requires much skill. A marine cable such as must be employed is itself a more or less delicate object. It demands that it be treated with consideration. When joints are to be made, they must be made properly if satisfactory results are to follow. A job hastily done might suffice if the cables were to be used immediately, but a mine must be put down so that it can remain in perfect condition for weeks, possibly months, and yet always be ready for instant use.

"The second class of defensive work is in the training and firing of coast-defense guns. These are naturally large and powerful, yet they must be handled quickly and delicately. For this purpose the electric motor is being introduced in our coast defenses. The firing of the guns, in case of an attack, would, in general, be controlled from a station, somewhat in the same way as is the firing of the mines. The gunner would be given the range. He would then train his gun and would fire upon a signal from the station. Or the gun might even be fired by the commanding officer himself, who would naturally be at the fire-control station."

The department of electricity and mines for the United States Army is at the School of Submarine Defense, at Fort Totten, New York, and here selected graduates from the Military Academy at West Point are trained, both by reading and by practical work, in the construction and handling of the scientific mechanism of defense. The work includes not only the construction, placing, and explosion of mines, but also other electrical work, such as the handling of telephone communication, to which has been added the telautograph as a valuable auxiliary.

In addition to the training of artillery officers, instruction is also given to a certain number of men as expert electricians, their training including all kinds of shop work, so chosen as to render them skilled mechanics. The system is intended to render this branch of the service independent and self-reliant. The work of the school at Fort Totten is in addition to that conducted at the Artillery School at Fort Monroe, Virginia, this latter being intended to give all artillery officers that general knowledge of electricity which forms a portion of their equipment.

THE PANAMA CANAL.

A REVIEW OF THE SERIOUS OBJECTIONS TO THE CONSTRUCTION OF A SEA-LEVEL CANAL ACROSS THE ISTHMUS.

Major Cassius E. Gillette—Engineering News.

AT the present time, before the actual plans for the construction of the Panama canal have been completed it is of interest to consider everything which may have a bearing upon the building and operation of such a monumental work. Especially is it important that the difficulties which stand in the way of the construction of a sea-level channel be fully considered before the commission is committed to a plan which, while offering many attractions, is also open to serious objections. In a paper contributed to a recent issue of *Engineering News*, Major Cassius E. Gillette discusses the difficulties surrounding the sea-level scheme, and while

the length of the paper prevents more than an abstract in these pages attention may be called to it as a valuable contribution to the literature of this great undertaking.

"Most reports and writings on the subject seem to take it for ganted that a sea-level canal is the only one that will fulfil this important condition, but such a conclusion is by no means borne out by the facts.

"Another seemingly off-hand conclusion that has been announced in nearly if not quite all of the reports of commissions and technical committees on the subject, is that a dam is not practicable at any site north of Bohio. Up to quite recently this pronouncement never appears to have been based on any borings, or other ascertained facts. The Chief Engineer and the Engineering Committee of the recent Commission came to the same conclusion as regards the proposed site at Gatun, this conclusion apparently being based on two borings.

"The advantages of a canal involving a high dam at Gatun are so great in the controlling elements of cost, time of construction, serviceableness and ease of enlargement, that the discovery of the best location and the devising of a dam that will successfully fit that location, are problems worthy of the most thorough study and research."

One of the most serious elements in the problem, Major Gillette points out, is the fact that the upper Chagres river is on the east of the canal line while the mouth is on the west. With a sea-level canal, therefore, the river flow must be taken into the canal, or the stream must be kept on the east side throughout, since it is wholly impracticable to carry the canal across the river on a viaduct, as has been done in the past with small canals crossing moderate streams.

"Another factor of vast importance, which, however, has received scant consideration in the past is that of sediment.

"The upper Chagres is doubtless a clear-water stream at low stages, but how much sediment it actually carries in floods seems never to have been measured. Its condition at present, too, is no guarantee of what it will be when the canal is opened. At present the tropical jungle is so thick that no matter how hard it rains the water only reaches the ground gradually, and flows off slowly through the mass of ground verdure, so that it can cause little or no erosion. When the French company had a large force at work, a large area of this jungle was cleared and put under cultivation to raise supplies for the workmen. The same thing will occur again when the canal force is augmented, and it may be expected to continue indefinitely, since passing ships and regular trade will doubtless furnish a market for all the bananas that can be raised as far up every stream as a canoe can be pushed. The country is made up of very steep slopes of volcanic soil easily eroded, and every stream that flows into the canal will become a menace to it. The evil could, of course, be lessened by buying the land and forbidding agriculture, but this would be expensive, and would lose to the world the agriculture of a very rich region, whose products would probably be quite valuable to passing ships.

"The problem of disposing of the sediment of all these streams, if a sea-level canal be adopted, is a serious one. The canal must occupy the bottom of the narrow valley and its water surface, if on the sea-level plan, must be no less than 55 feet below the present river surface, its bottom 35 or 40 feet lower still, while its banks are of easily eroded material. The sediment from even the smaller streams cannot be neglected. The Mandigo river, for instance, seems to have a drainage area of ten or fifteen square miles, and as it is on the Atlantic side of the divide, it must be subject at times to torrential floods."

After comparing the various lock level schemes, covering the 30 foot, 60 foot, 85 foot, and 97.5 foot levels, Major Gillette expresses himself as wholly favorable to the 100 foot level, with a dam situated at Gatun, unless the same dam can be placed further down stream.

"This is forbidden by the topography, the range of hills crossing at Gatun being the farthest one north that has sufficient height. Such a dam would give a lake having an area of at least 100 square miles, subject to very slight fluctuations, and capable of settling for ages all the mud that the streams would bring into it, and with

no current of moment in its narrowest parts during the highest floods.

"In the dry season it would have for lockage, not only the flow of the Chagres proper, but its own immense storage, and the flow of the Trinidad, Gatuncillo, and other numerous tributaries located in the region of the heaviest rainfall. The dam could be built of the spoil from the Culebra cut, and its cost per ton would be only the cost of hauling it about 25 extra miles. It has to be loaded on the cars and hauled several miles and be dumped in any event. Moreover, dump grounds of the necessary capacity are not plentiful near Culebra, and it is quite probable that the later excavation may have to be hauled quite long distances.

"By such a dam all the expense of the nine miles of crooked canal between Bohio and Gatun would be saved, and replaced by the open navigation of a broad, deep lake. The Gatuncillo would be taken into this lake and all trouble from it removed.

"The saving in cost would be so great that the funds now authorized could probably cover also a canal through the summit cut deep enough and wide enough for all future needs, as well as a deep and wide straight entrance to the locks from Limon Bay, both conducing to safety and celerity of passage."

The general construction of the dam suggested by Major Gillette is the same as that proposed by the late George S. Morison for a dam at Bohio, being two rock dams placed about 2,000 feet apart, with an earth fill between. The strength of such a structure would be ample, while the seepage would be trifling, the dam forming really a filter bed 2,000 feet thick which would soon become entirely clogged.

"In this, as in all other suggested plans, the auxiliary works can all be readily completed before the Culebra cut. This plan, involving the least work on that cut, can therefore be completed the soonest. It should be noted that comparisons of time and cost of the various plans cannot be correctly based on the comparative amounts of excavation alone. As the cut is deepened, contingencies as to slides, congestion of plant, drainage, and increase in hardness and quantity of rock, must be allowed for. The removal of one yard of material below sea level for that type of canal, when the cost of pumping and the other above contingencies are counted, will doubtless amount to more than the cost of removing five or six yards for the 100-foot level canal, and the proportionate delays would make the matter of time much worse for the sea-level canal. It has been estimated that the latter can be completed in ten or twelve years. If so, the 100-foot level should be finished in less than five years.

"Under these circumstances it would appear proper to give the dam site at Gatun a much more thorough examination than has heretofore apparently been accorded it.

MECHANICAL EFFICIENCIES OF INTERNAL-COMBUSTION MOTORS.

METHODS OF DETERMINING THE DISTRIBUTIOOF THE INTERNAL RESISTANCE OF GAS ENGINES.

Rudolph Diesel—Verein Deutscher Ingenieure.

SEVERAL months ago we reviewed in these columns the discussion which took place in the Society of German Engineers upon the question of the proper method determining the mechanical efficiency of an internal-combustion motor, and since that time there have been some additional contributions to the discussion, which is by no means closed.

It may be recalled that the matter under discussion involves a fundamental definition, which, while it has never arisen in the case of the steam engine, and is of negligible importance in the case of small gas engines, becomes more important when the larger sizes of gas engines of modern design are considered. Ordinarily the mechanical efficiency of an engine is supposed to be the the ratio of the indicated power of the brake horse power, and it is intended to show the excellence of the mechanical performance of the machine as distinguished from its thermal performance. In the case of the steam engine the indicator diagram is supposed to show the total power developed in the

cylinder, that is, the heat energy converted into mechanical energy, while the losses due to friction, etc., occur between the cylinder and the delivery belt.

In the case of the gas engine, however, the conditions are not altogether the same, and the result is that there is room for difference of opinion. In the ordinary four-cycle engine, the compression stroke takes place in the same cylinder as the power stroke, and its resistance appears on the indicator diagram. In the case of a two-cycle engine, however, the resistance of the compression pump is not apparent on the main indicator diagram, and if it is allowed to go in with the other internal resistances of the engine the mechanical efficiency will be correspondingly apparently increased.

If, however, indicator diagrams are taken from the compression pump, and its resistance deducted from the power developed in the power cylinder, the mechanical efficiency will be correspondingly lowered.

From the standpoint of the user of the engine no method can be satisfactory which does not include the real amount of power available for driving his useful machinery, and he is not interested in the power required to drive the pump, since it is not at his disposal for manufacturing purposes. It is, therefore, always desirable that the brake horse-power of an engine be stated. The designer, however, is interested in knowing how the internal resistances of an engine are distributed, and it is certainly desirable that uniformity of practice in this respect be observed, especially in connection with reports of tests and trials.

In a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* there is given a further addition to the discussion of the question by Mr. Rudolf Diesel, who is well qualified by experience in the design and construction of internal-combustion motors to speak upon the subject. Mr. Diesel takes up the matter in the true scientific problem, not as a question for dispute, but rather a laboratory problem, to get at the truth. He believes that the question is largely one of definition, and that the uncertainty existing at present would be removed by the adoption, by some authoritative body, such as the Society of German Engineers, of determinate meanings for the various expressions employed. His nomenclature is as follows:

Indicated power; means the full power indicated in the working cylinder without any deductions.

Useful power; the bare amount of power wholly available for external work.

Effective power; the useful power, as defined above, plus the work required to operate the compression pumps.

Mechanical efficiency; the useful power divided by the indicated power, according to the above definitions.

Dynamic efficiency; the effective power divided by the indicated power.

Pump ratio; the result obtained by dividing the work required for the pump by the indicated power.

Friction ratio; the difference between unity and the dynamic efficiency.

It may seem rather elaborate to insist upon so many classifications, but these various elements are all there, and they all have to be taken into account, either in public tests or in private study and research, and hence it is most important that they should have recorded names and definitions, concerning which there can be no dispute, and to which authoritative reference may be made. In the course of the development of the Diesel motor a remarkably high thermal efficiency was attained at the start, while a considerable proportion of the power derived from the fuel was absorbed in the various mechanical resistances of the machine, partly owing, no doubt, to the high working pressures involved. As experience was gained in the construction and operation of the machine these internal resistances were materially diminished, and in the motors of more recent construction a much greater portion of the power developed in the cylinder is available for external work, so that Mr. Diesel knows very well the nature and magnitude of the internal resistance which the engineer encounters in such work.

Like many other disputes and discussions, differences of opinion arise when men are not talking about the same thing, and as soon as clear and comprehensive definitions of the terms included in the

argument are adopted the differences naturally disappear. The engineering profession will do well to examine these definitions suggested by Mr. Diesel, and should they receive approval they may well be incorporated in the various codes for testing steam and gas engines.

It is a matter of interest to note that while this discussion has not actively arisen in connection with steam engine trials, the elements for the same differences exist as in the case of internal-cumbustion motors. Thus, in the case of the ordinary condensing engine, as it has been built since the days of Watt, the air pump has been driven by the engine itself, thus forming a resistance not materially different in nature from the compressing pump of the gas engine. In recent years, however, especially for large marine engines, it has not been unusual to find the air and circulating pumps operated independently, and this practice is also entering into stationary power-plant design. Unless the engine in the latter case is charged with the power required for these independent pumps, its mechanical efficiency, according to the usual definition, is not computed on the same basis as in the case of the engine in which the air pump is directly connected to the crank or cross-head. By using the broad definition suggested by Mr. Diesel, however, any uncertainty as to the meaning of the expressions will be removed, regardless of the kind of engine to which they may be applied.

THE GEOLOGY OF THE SIMPLON TUNNEL.

SCIENTIFIC DATA AND INFORMATION OBTAINED IN CONNECTION WITH THE LATEST PIERCING OF THE ALPS.

H. Schardt—Bulletin Technique de la Suisse Romande.

WE have repeatedly noticed the work upon the Simplon tunnel from its beginning until the meeting of the headings in February last, and have also examined the changes and modifications which its operation may make in the railway connections of central Europe. There is another side to this important work, however, which, while not directly connected with its engineering features, is really of much importance; that is, the additions which its construction has made to the general stock of information about the nature of rock formations and of water-courses in the interior of the Alps, and of similar mountain ranges. In a series of interesting articles in recent issues of the *Bulletin Technique de la Suisse Romande,* Professor H. Schardt gives a résumé of the scientific results of the piercing of the Simplon, from which we make an abstract.

Before the work upon the tunnel was begun the geology of the mountain was made the subject of careful study, with the object of determining, so far as possible, the nature of the strata through which the passage was to be made. The nature of the interior of the mountain was based upon the investigations of Bernard Studer in 1851; of Gerlach, in 1869; of Renevier, in 1878; and of Heim, Lory, and Taranvelli, down to 1882. These, however, were made in view of the construction of a tunnel at a high altitude, and when the present plan for a tunnel, with a maximum elevation of only 705 metres above sea level, was considered, it was thought advisable to have a later examination of the geology of the route. This work was undertaken by Professor Schardt himself, in 1890, and a geological map, together with a profile, showing the supposed formation of the interior of Monte Leone, was prepared.

As the work on the tunnel proceeded it became evident that the nature and position of the strata were materially different from what had been inferred, and the successive modifications in the profile along the line of the tunnel are very clearly shown in Professor Schardt's articles. The actual perforation of the tunnel revealed the existence of remarkable plications and reversals in the older strata beneath the recent ones. The result was the appearance in the tunnel of horizontal strata, where it had been supposed that the layers of rock would have been almost vertical, this causing increased difficulty in the working, owing to the fact that the natural

roof ceased to be self-sustaining. There were four distinct formations encountered in the tunnel; the Jura-Trias formation, consisting of clayey, micaceous, and calcareous schists; the Trias, white dolomite, gray calcareous dolomite, and quartzite; Crystalline Schists, considered to be paleozoic, probably partly triassic or metamorphic Jurassic; and finally the primitive gneiss, the gneiss of Antigorio, and schistose gneiss of Monte Leone.

Under the enormous pressure these rocks appeared transformed from their ordinary characteristics. The lustrous schists resembled mica-schists or micaceous calc-schists; the triassic quartzites had the appearance of gneiss; rocks really almost identical appeared different, while those quite different resembled each other. In this respect the result in the Simplon was very different from that of the Saint Gothard. In the piercing of the latter tunnel the profile constructed by M. von Fritsch was almost wholly verified by the completed work, while in the case of the Simplon the results differed greatly from the prediction.

In addition to the unexpected geological conditions developed by the boring of the Simplon tunnel there appeared the remarkable irruptions of both hot and cold water.

It was to be expected that a moderate number of springs would be encountered in the course of the work, in view of the existence of various water courses upon the surface. The enormous volume of water which appeared in the heart of the mountain, was entirely unexpected, however, and its origin is even yet unaccounted for. In many instances the temperature of the discharged water was higher than that of the rock from which it flowed, while in other cases the temperatures of the water and the rock were about the same. The flow of cold water, however, was greater than the discharge of the hot springs, the total volume of water at the time of maximum flow aggregaing about 1,200 litres from all the hot springs, or about 42 cubic feet per second. An interesting feature about these springs is the fact that they appear to have an annual periodicity, both as to volume and temperature. The cold springs attain their highest temperature, about 18 degrees Centigrade, in the month of April, falling to 14 degrees in July, and rising again during the autumn and winter. The greatest flow occurs in July and the minimum in April, the maximum discharge being 30 to 40 per cent. greater than the minimum, and entirely independent of any surface conditions. The water from these springs is highly charged with sulphate of lime from the deposits of gypsum and anhydrite occurring in the triassic marbles, the average content being one gramme of gypsum per litre of water. Professor Schardt calls attention to the fact that a discharge of 1,000 litres of water per second, with a content of one gramme per litre of sulphate of lime, corresponds to a weight of 31,530 metric tons of gypsum per year, dissolved out of the heart of the mountain, a noteworthy example of the eroding power of water flow in the earth.

The question of the internal temperature of the mountain is also considered by Professor Schardt. Assuming the increased temperature in the interior to depend upon the height of the mass above, various computations of the probable temperature in the interior of Monte Leone were made in advance of the boring of the tunnel. Thus Stockalper, the engineer-in-chief of the northern end of the Saint Gothard tunnel, computed that the heat would reach 36 degrees centigrade, under the Furggenbaumgrat, where the altitude above reached 2,050 metres. Strapff, the geologist of the St. Gothard, however, maintained that the internal temperature would reach 47 degrees in a tunnel pierced at the level of Brieg, and advised that the mountain be pierced at a level of 500 metres higher. As a matter of fact, the temperature in the Simplon tunnel for a length of about two kilometers in the middle of the rocks remains at 50 degrees centigrade, or 122 degrees F. The actual temperature of the interior of the tunnel is maintained at a bearable degree, the above figures being obtained by the insertion of a thermometer into bore holes in the rocks for the purpose of obtaining the true heat. By the spraying of cold water, and by a powerful system of ventilation through the auxiliary tunnel, the temperature of its atmosphere may be well controlled.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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Arched Girders with Elastic Abutments (Bogenträger mit Elastisch Eingespannten Kämpfern). Adolf Francke. A mathematical investigation, computing the stresses for a number of cases. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 20, 1905. No. 70958 D.

Empirical Formulas for Reinforced Arches. Daniel B. Luten. Gives rules governing the design, with views and sections of bridges designed in accordance, and describes their erection. 1000 w. Cement—July, 1905. No. 70775 C.

Race Street Concrete Arch, Ypsilanti, Michigan. W. L. Luten. Illustrates and describes the construction. 800 w. Cement—July, 1905. No. 70774 C.

The Connecticut Avenue Concrete Arch Bridge, Washington, D. C. An illustrated description of progress in the erection. 3000 w. Eng Rec—July 8, 1905. No. 70694.

We supply copies of these articles. See page 991.

Bascule.

Bascule Bridge of the New Orleans Terminal Company. Brief illustrated description of a recently completed bridge across New Basin Canal. 500 w. R R Gaz—Vol. XXXIX. No. 4. No. 71074.

Erection.

Cantilever Erection of Simple Riveted Railroad Spans. Illustrates and describes the methods of erection used on the extension of the Western Maryland Railroad. 3000 w. Eng Rec—July 15, 1905. No. 70781.

Floors.

Reinforced Concrete for Bridge Floors (Betoneisentragwerke für Strassenbrücken). Anton Kraupa. Computations of strength for various distributions of load; with details of construction. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—June 10, 1905. No. 70961 D.

Highway Bridge.

Highway Bridge over the Wabash at Terre Haute Indiana. Illustrated detailed description of this new bridge and the methods of erection. It is composed of 6 spans of 120 ft., and one of 75 ft., in the center. 1200 w. R R Gaz—Vol. XXXIX., No. 1. No. 70676.

Manhattan.

Cables for the Manhattan Bridge. Gives drawings showing some of the details of the cable connections and suspenders, with information from the specifications. 1300 w. R R Gaz—Vol. XXXIX. No. 4. No. 71073.

Reconstruction.

The Tennessee River Bridge of the Illinois Central. H. W. Parkhurst. Illustrated description of a new bridge constructed on a new site, the line being diverted to take out nearly 120 deg. of curvature, and of the methods of erection. 3300 w. R R Gaz—Vol. XXXIX. No. 2. No. 70770.

Thebes.

The Thebes Bridge Superstructure. Brief illustrated description of the steel superstructure of one of the largest bridges across the Mississippi River. 1500 w. Eng Rec—July 22, 1905. No. 71022.

Viaducts.

The Newark Viaducts of the Lackawanna Railroad. Illustrated detailed description of work made necessary in the elimination of grade crossings of the D. L. & W. R. R. 1800 w. Eng Rec—July 22, 1905. No. 71024.

Vierendeel System.

The Vierendeel System of Metal Bridges (Les Ponts Métalliques, System Vierendeel). A Morizot. Describing especially the bridge at Avelghem, Belgium, of a plate-girder type, pierced with rectangular openings. 2500 w. 1 plate. Génie Civil—June 17, 1905. No. 70915 D.

Zambesi.

Bridge Over the River Zambesi at Victoria Falls, Rhodesia. An illustrated detailed account of the design and erection of this remarkable bridge at Victoria Falls. 4000 w. Engng—July 7, 1905. Serial. 1st part. No. 70789 A.

Completion of Victoria Falls Bridge. Gives interesting illustrations of this great engineering work in Central Africa, with some facts about the Cape-to-Cairo railroad and the methods of erection of the bridge. 2000 w. Sci Am—July 22, 1905. No. 70834.

CONSTRUCTION.

Building Details.

Column and Girder Details in a Loft Building. Brief illustrated description of details of a ten-story and basement building in New York, with a statement of the advantages claimed by the designers. 1000 w. Eng Rec—July 1, 1905. No. 70602.

Heavy Plate Girders in the Bellevue-Stratford Hotel Extension. Gives an illustrated description of unusual construction, made in order to secure an unobstructed 60 x 80 ft. floor area in a ballroom. 800 w. Eng Rec—July 15, 1905. No. 70783.

Coffer-Dams.

Construction of Coffer-Dams. Thomas P. Roberts. A brief description of cofferdam construction, with general discussion. 5000 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71103 D.

Columns.

The Strength of Columns. Prof. W. E. Lilly. Read before the Inst. of Mech. Engrs. An account of experiments carried out to determine the conditions under which failure takes place either by primary or secondary flexure, and to obtain information as to the values of the areas and radii of the gyration of economic cross-sections. 1500 w. Mech Engr—July 8, 1905. Serial. 1st part. No. 70787 A.

Cost Keeping.

See Industrial Economy.

Dams.

Failure of Lake Avalon Dam, near Carlsbad, N. M. E. C. Murphy. Describes the construction and gives a brief account of the two failures of this dam, discussing the cause of the second failure. Ills. 1000 w. Eng News—July 6, 1905. No. 70613.

On the Distribution of Shearing Stress in Masonry Dams. Prof. W. C. Unwin. An examination of shearing stress in dams of various forms. 900 w. Engng—June 30, 1905. No. 70721 A.

On the Stability of Masonry Dams. Karl Pearson. A reply to critical papers

by Prof. W. C. Unwin. 2500 w. Engng —July 14, 1905. No. 70893 A.

Pile Foundations for Movable Dam, at McMechen, W. Va., with Method of Calculation. Gilbert S. Walker. Briefly describes the four principal types of foundations which were considered, and gives details of the type adopted. Ills. 2400 w. Eng News—July 27, 1905. No. 71068.

Dome.

The Construction of a Stone Dome. James S. Boyd. Read before the Glasgow and W. of Scotland Tech. Col. Archt. Crafts Soc. Illustrates and describes the constructional and practical part of the work connected with a dome of moderate size, and the principles of stone dome construction. 2800 w. Am Archt—July 22, 1905. No. 70886.

Excavation.

Methods of Subaqueous Rock Excavation, Buffalo Harbor, N. Y. Brief illustrated article describing the plant used in this work of improving the Lake Erie entrance to Black Rock Harbor and Erie Basin, N. Y. 1000 w. Eng News—July 6, 1905. No. 70611.

Fireproof.

Uniform Building Laws. Gives the recommendations of the National Board of Fire Underwriters for the construction of fireproof buildings. 5000 w. Ins Engng —July, 1905. No. 70798 C.

Foundations.

Steel Sheet Piling to Secure an Old Foundation. Describes methods adopted in building an extension to the Tribune Building, New York City, where the foundations were to be carried 7½ feet below the footings of the present building. Ills. 800 w. Eng Rec—July 15, 1905. No. 70785.

Reinforced Concrete.

Bending Moments in Continuous Reinforced Concrete Beams. Translated from *Beton u. Eisen.* O. Gottschalk. An interesting discussion of the bending moments in a continuous beam over three supports, especially at the mid-support. 1000 w. Cement—July, 1905. No. 70773 C.

European Reinforced Concrete Piles. Abstract of a paper by A. R. Galbraith, presented to the Assn. of Munic. & Co. Engrs. The methods of manufacture, the driving, and the various types of molded piles are discussed. 2500 w. Eng Rec—July 22, 1905. No. 71023.

Ferro-Concrete in Belgium. Ed Noaillon. Read before the Inst. of Mech. Engrs., at Liége. States the properties of this material, and describes applications made of it in Belgium. Ills. 8000 w. Engng—June 23, 1905. No. 70640 A.

Reinforced Concrete Bridge Floors, Culverts and Abutments, Wabash, R. R. Illustrated description of approved construction. 1600 w. Ry and Engng Rev—July 15, 1905. No. 70768.

Reinforced Concrete Chapel Building, U. S. Naval Academy, Annapolis, Md. An illustrated description of the reinforced concrete work on this new chapel building. 1800 w. Eng News—July 13, 1905. No. 70739.

Reinforced Concrete Fence Posts Molded in the Ground. Describes the materials used and the construction of this form of post. Ills. 1000 w. Eng News—July 20, 1905. No. 70828.

Reinforced Concrete—Some of Its Principles, with Practical Illustrations. Walter Loring Webb. Discusses some satisfactory uses of this material, its economy, effect of elastic limit of the steel, stresses, expansion joints, steel-concrete tanks, protection of steel from rusting by concrete, etc. General discussion. 8000 w. Pro Engrs' Club of Phila—July, 1905. No. 70865 D.

Tests of the Efficiency of Vertical Stirrups in Reinforced Concrete Beams. An illustrated report of tests made at the yards of the Bush Terminal Co., Brooklyn, N. Y., to determine the behavior of beams provided with vertical stirrups in place of inclined metal. 1500 w. Eng News—July 6, 1905. No. 70612.

See Civil Engineering, Bridges.

Roof Truss.

The Numerical Determination of the Maximum Stresses in a Roof Truss (Zeichnerische Bestimmung der Grossten Strebenkraft'e eines Fachwerkbalkenträgers). Paul Neumann. An application of the graphical analysis, showing the practical details of computation. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 24, 1905. No. 70963 D.

Tunnels.

The Applications of Electricity in Tunneling (Elektrotechnische Aufgaben im Tunnelbau). Arthur Hruschka. A discussion of the increasing applications of electric power for ventilators, rock drills, traction, and other departments of tunnel construction work. Three articles. 6000 w. Zeitschr f Elektrotechnik—May 21, 28. June 4, 1905. No. 70983 each D.

The Chicago Tunnels. Illustrates and describes the 30 miles of underground passages built for carrying telephone cables, and now to be operated for the carriage of mails, parcels and goods. 1000 w. Engr, Lond—July 14, 1905. Serial. 1st part. No. 70891 A.

The Scientific Results of the Piercing of the Simplon Tunnel (Les Resultats Scientifiques du Percement du Tunnel du Simplon). H. Schardt. A complete study of the geological, and physical information gained in the course of the boring of

the tunnel, from a scientific viewpoint. Serial. Part I. 3000 w. Bull Tech de la Suisse Romande—May 25, 1905. No. 70999 D.

Tunnel Boring and Mountain Pressures (Tunnelbau und Gebirgsdruck). C. J. Wagner. An examination of the influence of rock pressures in mountains upon the difficultv of tunneling. Serial. Part I. 2000 w. Schweiz Bauzeitung—July 1, 1905. No. 70956 B.

Underpinning.

Underpinning a 70 ft. Wall Without Temporary Supports. Brief description of methods used in building the addition to the Tribune Building, New York City. Ills. 1500 w. Eng Rec—July 22, 1905. No. 71018.

Walls.

Retaining Walls (Stutzwande) Zdenko Ritter von Limbeck. Discussing especially the peculiar advantages of properly designed reinforced concrete construction for retaining walls to resist the thrust of earth pressure. 2000 w. 1 Plate. Oesterr Wochenschr f d Oeffent Baudienst—July 8, 1905. No. 70965 D.

MATERIALS OF CONSTRUCTION.

Cement.

Low-pulling Portland Cements. W. A. Aiken. Read before the Am. Soc. of Test. Materials. Gives information obtained in testing cement for the N. Y. subway construction. 1200 w. Eng Rec—July 8, 1905. No. 70700.

The Cement Industry in the United States (L'Industrie du Ciment aux Etats Unis). George P. Roux. A review of the development of the manufacture of Portland cement in America, from a French viewpoint. 6000 w. Mem Soc Ing Civ de France—May, 1905. No. 70933 G.

The Development of the Portland Cement Industry (Le Progres de l'Industrie du Ciment Portland). E. Candlot. An historical review of the cement industry, with especial reference to the development of the rotary kiln. 4000 w. Mem Soc Ing Civ de France—May, 1905. No. 70934 G.

Concrete.

Concrete. Brysson Cunningham. Considers its composition, giving a detailed discussion of its preparation and uses. Ills. 3500 w. Sci Am Sup—July 29, 1905. No. 71083.

Investigation of the Effect of Heat Upon the Crushing Strength and Elastic Properties of Concrete. Ira H. Woolson. Read before the Am. Soc. for Test. Materials. Reports investigation made of this subject with details of experiments. Ills. 3800 w. Eng News—July 13, 1905. No. 70742.

The Fire Resistance of Different Concretes. Reports the results of tests made by the Committee on Cement for Building Construction of the National Fire Protection Association. 1700 w. Eng Rec—July 22, 1905. No. 71021.

Paint.

Proper Methods in Conducting Painting Tests. Gustave W. Thompson. Read before the Am. Soc. for Test. Materials. A discussion of painting tests made on paints used for the purpose of producing a desired finish of appearance. 3300 w. Eng Rec—July 15, 1905. No. 70782.

Stresses.

The Permissible Stresses upon a Material Subjected to Forces Acting in Several Directions (Die Zulässige Anstrengung eines Materials bei Belastung nach Mehreren Richtungen). H. Wehage. An examination of the stresses caused by multiple loading, with formulas for determining the maximum stress. 3000 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70913 D.

Testing.

The Testing Engineer. Presidential address by Dr. C. B. Dudley before the American Society for Testing Materials. Gives an analysis of the scope and field of the testing engineer, and remarks on the preparation needed. 4500 w. Eng Rec—July 8, 1905. No. 70697.

Timber.

Tests of Structural Timber (Essais des Bois de Construction). J. Malette. A discussion of the common defects in timber, and the best methods of testing according to the conditions of usage. 3000 w. Revue Technique—April 25, 1905. No. 70930 D.

Torsion.

The Work of Deformation in Torsion (Zur Frage: Formänderungsarbeit bei Torsion). M. T. Huber. A criticism of the theory of Professor Zschetzsche, with a reply by the latter. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 3, 1905. No. 70960 D.

MEASUREMENT.

Mensuration.

A Problem in the Storage of Granular and Lump Material. W. E. Hunter and J. S. Myers. Gives diagrams for computing the contents of conical piles of material enclosed by walls at the base, with notes. 1000 w. Eng News—July 27, 1905. No. 71065.

Mine Surveying.

See Mining and Metallurgy, Mining.

Recorder.

An Electrical Long Distance Water-Level Indicator. Illustrates and describes an apparatus designed by Hans Baumeis-

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ter, of Vienna, for recording the water level of a river, at a distance. 1600 w. Sci Am Sup—July 22, 1905. No. 70837.

Surveying.

Methods of Filing Records in a City Surveyor's Office. Fred Gabelman. Describes a system of indexing developed, which enabled information desired to be quickly available. 2500 w. Eng News—July 20, 1905. No. 70826.

Stereoscopic Vision Applied to Surveying. E. F. Northrup. Brief description of the "Telemeter" and the "Stereocomparator," two instruments making use of the principle of stereoscopic vision. Discussion. 1800 w. Pro Engrs' Club of Phila—July, 1905. No. 70868 D.

Wind Pressure.

The Danger of Wind Pressure in Railway Operation (Die Gefahr des Sturmwindes im Eisenbahnverkehr). Anton Syha. An examination of the influence of wind pressure upon trains, describing a recording gauge for measuring wind pressure. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—June 17, 1905. No. 70962 D.

MUNICIPAL.

Electric Stations.

See Electrical Engineering, Generating Stations.

Highways.

Highways of France. William Ballantine. Reports an inspection of the boulevards and avenues of Paris and roads of the surrounding districts. 3500 w. Munic Jour of Engr—July, 1905. Serial. 1st part. No. 70569 C.

Methods of Preventing Dust on Roads (Moyens de Combattre la Poussière sur les Routes). Dr. Guglielminetti. Describing especially the appliances used for sprinkling the roads between Nice, Monte Carlo and Mentone. 3000 w. Génie Civil—June 24, 1905. No. 70917 D.

The Need of Systematic Instruction in Highway Engineering. A. N. Johnson. Read before the Soc for the Promotion of Engng. Education. Remarks on the large sums of money being expended for the improvement of highways, and the need of experienced men for supervision. 1500 w. Eng Rec—July 8, 1905. No. 70699.

Manila.

The Engineering Development of Manila Under American Dominion. Robt. G. Dieck. An account of the many improvements since the city has been under American control. Also discussion. 4000 w. Pro Engrs' Club of Phila—July, 1905. No. 70864 D.

Office-Buildings.

Sanitation of Office Buildings. Henry Leffmann. A condemnation of some conditions often found in these buildings. General discussion. 4800 w. Pro Engrs' Club of Phila—July, 1905. No. 70866 D.

Pavements.

Wood Paving. T. H. Scott. Information about the use of wood paving in English cities. 2000 w. Munic Jour & Engr—July, 1905. No. 70568 C.

Pipe Tunnel.

Pipe Tunnel at Dover St. Bridge, Boston. Frederic I. Winslow. Brief illustrated description of this work. 700 w. Eng News—July 13, 1905. No. 70744.

Refuse.

City Refuse as Fuel in Electric Plants. George E. Walsh. Discusses what has been accomplished in England and recent improvements that have been introduced. 2800 w. Am Elect'n—July, 1905. No. 70605.

Sewage-Disposal.

Sewage Disposal at Elmhurst, N. Y. Illustrates and describes a recently completed plant on Long Island, designed to treat 1,000,000 gallons of sewage per day by sedimentation and intermittent sand filtration. 2200 w. Eng Rec—July 22, 1905. No. 71017.

Sewage Disposal at Hampton, England. An explanation of these works, taken from *The Surveyor*. 2200 w. Eng Rec—July 22, 1905. No. 71019.

Sewage Disposal. Morrell Vrooman. Digest of a paper read before the League of Am. Municipalities. Briefly discusses various methods of disposal. 3500 w. Munic Jour and Engr—July, 1905. No. 70570 C.

The Bacteriological Treatment of Sewage. F. Herbert Snow. Reviews the work of investigators in this field, giving a summary of what is now known about bacterial treatment of sewage by the various processes. Also general discussion. 12800 w. Pro Engrs' Club of Phila—July, 1905. No. 70869 D.

Sewers.

The Efficiency of the New Haven Sewerage System. Frederick Jackson. From a paper before the Conn. Assn. of Civ. Engrs. Explains the method used to determine the efficiency of this sewerage system. 2500 w. Munic Engng—July, 1905. No. 70863 C.

The Proportioning of Municipal Sewerage Plants (Die Berechnung Städtischer Kanalisationsanlagen). H. Heyd. A general discussion of the provision for rainfalls of various force and duration, illustrated by the sewer system of the City of Darmstadt. 4000 w. 2 plates. Gesundheits Ingenieur—July 16, 1905. No. 70997 B.

Tables for the Computation of Sewers

and Drain Pipes (Vereinfachte Tabellen zur Berechnung von Kanal oder Rohrquerschnitten für Kanalisationsanlagen). Max Schendera. Tables for circular pipes and for egg-shaped sewers, with diagrams for the determination of coefficients. 3500 w. Gesundheits Ingenieur—June 30, 1905. No. 70996 B.

Snow.

A Novel Snow Compressing Machine. Illustrates and describes a machine for dealing with snow in city streets. 1400 w. Eng News—July 27, 1905. No. 71067.

Surveying.

See Civil Engineering, Measurement.

WATER SUPPLY.

Filtration.

A Modern Filtration Plant. James G. Fernald. Illustrated description of the plant now under construction at Washington, D. C., the second largest in the world. 2000 w. Sci Am—July 29, 1905. No. 71080.

Operation of Sand Filters of Indianapolis Water-Works. W. C. Mabee. Extract from a paper read before the Indianapolis Technical Club. Illustrates and describes the method of operating these filters. 2500 w. Munic Engng—July, 1905. No. 70862 C.

South Bethlehem Filtration Plant. P. A. Maignen. Digest of a paper read before the Am. W. Wks. Assn. Illustrated general description of an improved slow sand system and its operation. 2500 w. Munic Jour and Engr—July, 1905. No. 70567 C.

Fire Systems.

High Pressure Fire Systems. Everett U. Crosby. Committee report adopted by the National Fire Protection Association. 4500 w. Ins Engng—July, 1905. No. 70799 C.

Irrigation.

The Industrial West. An illustrated article explaining how oil fuel has made irrigation possible, describing the irrigation wells, the manufacture of pumps and engines for the industry, etc. 3000 w. Am Mach—Vol. 28. No. 30. No. 71070.

Madrid.

The Water-Works Catastrophe in Madrid. T. A. Greenhill. An illustrated account of the failure of the reinforced concrete covering of a service reservoir. 2000 w. Eng Rec—July 22, 1905. No. 71016.

Pumping.

The Selection of Water-Works Pumping Machinery. Nicholas S. Hill, jr. A discussion of this subject from the standpoint of the purchaser. The present number gives an outline indicating the essential features to be covered by a specification. 5000 w. Eng Rec—July 8, 1905. Serial. 1st part. No. 70696.

Purification.

Water Purification at South Bethlehem, Pa. Illustrated description of the filtration. 3800 w. Eng. Rec—July 15, 1905. No. 70780.

Rainfall.

Rainfall and Run Off (Regenabfluss und Abflussverzögerung). W. Krawinkel. A study of the surface and underground run-off for various conditions, with data for the proportions of sewers and drainage channels. Two articles. 4500 w. Gesundheits-Ingenieur—May 10, June 10, 1905. No. 70994 each B.

Springs.

Artificial Fountain and Geyser Springs. Myron L. Fuller. Describes the methods of constructing fountain springs and geyser springs, illustrating types. 1200 w. Sci Am—July 22, 1905. No. 70833.

Supply.

Shall We All Die of Thirst? J. E. Whitby. Remarks on the future outlook for the water supply; showing that the waters of the earth are drying up, and discussing briefly the causes, and the possible remedy. 1100 w. Sci Am Sup—July 22, 1905. No. 70839.

Water Analysis.

Progress in Standardization of Water Analysis in the United States. Information from the final report of the Committee of the American Public Health Assn., outlining the new requirements for the water analyst, and the best practice in America. 1800 w. Eng Rec—July 8, 1905. No. 70695.

WATERWAYS AND HARBORS.

Backwater.

The Computation of Backwater Curves (Beitrag zur Berechnung von Staukurven). Bretislav Tolman. An examination of the various formulas for computing the extent to which water is backed up by obstructions in a stream, compared with actual results on the Moldau at Prague. Two articles. 8000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—July 1, 8, 1905. No. 70964 each D.

Canal Haulage.

Modern Electric Canal Haulage. An illustrated article describing the electric canal haulage locomotive tried on the Teltow Canal, and other systems of electric canal haulage. 2000 w. Mod Mach—July, 1905. No. 70562.

Canal Lift.

The Electric Portion of the Prize Canal Lift Project (Der Elektrische Teil des Preisgekrönten Schiffshebewerk Projektes "Universell"). Josef Rothmüller. Details of the electrical hoisting machinery for the inclined plane lift proposed for the Danube-Moldau Canal. Serial. Part I.

3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 30, 1905. No. 70929 D.

Crane.

10-Ton Electric Travelling Jib-Crane. Illustrated detailed description of a jib-crane shown at the Liége Exhibition, and constructed for the Maritime Station, Brussels. 800 w. Engng—June 30, 1905. No. 70723 A.

Dry Docks.

The Comparative Merits of Floating Docks and Graving Docks. From the report of the Massachusetts State Board of Harbor and Land Commissioners concerning the relative merits of graving docks and floating docks. 4500 w. Eng News—July 20, 1905. No. 70830.

Nile.

Sir William Preece and "The Navigation of the Nile." Sir Hanbury Brown. A review of a paper read 1st of February, 1905, before the Society of Arts in London, with a defence of the writer of it. 3300 w. Engr, Lond—July 14, 1905. No. 70889 A.

Panama.

The Panama Canal: Some Serious Objections to the Sea Level Plan. Cassius E. Gillette. Proposes a lock canal with a dam at Gatun, pointing out its advantages. Discusses the question of the disposition of floods and silt from the streams in the Chagres Valley. Ills. 6000 w. Eng News—July 27, 1905. No. 71061.

The Present Status of the Panama Canal. C. F. Z. Caracristi. An able discussion of the causes of delay in this work, and of the resignation of the chief engineer, the sanitation of the isthmus, and related topics. 4000 w. Mfrs Rec—July 13, 1905. No. 70720.

Sea-Wall Failure.

Failure of a Concrete Sea-wall. George W. Blodgett. An illustrated account of the breaks in the sea-wall at Hull, Mass., describing the conditions and the cause of the two breaks. 900 w. R R Gaz—Vol. XXXIX. No. 3. No. 70848.

Sounding.

A Trachometric Sounding Apparatus (Der Sondiertachygraph). Rudolf Reich. A description of the Reich-Ganser Stadia apparatus for the rapid conduct of hydrographic sounding and surveying. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—June 16, 23, 1905. No. 70928 each D.

MISCELLANY.

Reclamation.

Reclaiming of Bouldin Island, Cal. John A. Yeatman. Illustrated account of a very difficult piece of reclamation work. 2000 w. Min & Sci Pr—July 8, 1905. No. 70777.

Sanitation.

Army Sanitation in Manchuria. A review of the address by Major Louis Livingston Seaman before the Committee on Military Affairs of the U. S. House of Representatives, concerning army sanitation, and the great success of Japanese methods. 2200 w. Sci Am Sup—July 8, 1905. No. 70623.

ELECTRICAL ENGINEERING

COMMUNICATION.

Combined Service.

Combined Telephony and Telegraphy. Samuel G. McMeen. Presented at the convention of the Nat. Inter-State Telephone Assn. Explains the advantages of combined working, and the plans of arrangement for different classes of service. 2500 w. Elec Rev, N. Y.—July 8, 1905. No. 70665.

Exchanges.

Terminals and Distribution Boards in Telephone Exchanges. Arthur V. Abbott. An illustrated article discussing methods now considered the best practice. 3300 w. Elec Wld & Engr—July 22, 1905. No. 71048.

Relay.

An Improved Relay System for Continuous Currents, with Mechanical Locking Device (Ueber eine Neue Ruhestrom Translation mit Mechanischer Verriegelung der Relaishebel). J. Jokisch. Details of the relay system in operation on the Austrian telegraph lines. 2000 w. Zeitschr f Elektrotechnik—May 21, 1905. No. 70984 D.

Space Telegraphy.

Design of the Telefunken System. A. Frederick Collins. Gives additional interesting features relating to this system. 2200 w. Elec Wld & Engr—July 22, 1905. No. 71046.

Present Problems in Space Telegraphy (I Problemi Attuali della Radiotelegrafia). Vincenzo Leone. A review of the progress made during the past year, with especial reference to the applications of space telegraphy to marine and naval service. 7500 w. Rivista Marittima—June, 1905. No. 71052 G.

Some Problems in the Wireless Transmission of Signals. L. H. Walter. The

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present article discusses the present standpoint of the transmission of energy; the improving of the transmitter efficiency, etc. 1600 w. Elec Mag—June 27, 1905. Serial. 1st part. No. 70812 A.

Stone Wireless Telegraph System. A description covering recent developments, and dealing especiallv with the practical features of the apparatus. 1700 w. Elec Wld & Engr—July 8, 1905. No. 70693.

The Murgas System of Wireless Telegraphy. Illustrates and describes this system which is in operation between Wilkesbarre and Scranton, Penn., discussing the difficulties that were overcome. apparatus. 900 w. Sci Am—July 8, 1905. No. 70760.

Telautograph.

The Improved Gruhn Telautograph. Dr. Alfred Gradenwitz. An illustrated description of great improvements in this apparatus. 900 w. Sci Am—July 8, 1905. No. 70619.

Telephony.

The Evolution of the Telephone. W. H. Sharp. Reviews the history of telephone evolution, leading to A. G. Bell's telephone "improvements" in 1876. 5000 w. Sci Am Sup—July 15, 1905. No. 70750.

War Telephones.

The Use of the Telephone by the Japanese Army at the Battle of Mukden. M. C. Sullivan. An account of the skilful use made of the telephone in handling the Japanese army. 1500 w. Elec Rev, N. Y. —July 1, 1905. No. 70572.

Waves.

Electrical Waves and the Behavior of Long-distance Transmission in Lines. W. S. Franklin. Develops Maxwell's mechanical conceptions of electromagnetism and applies them to the discussion of electromagnetic waves. Also discusses wave distortion on telephone lines; the effect of line resistance and line leackage, etc. Ills. 5000 w. Jour Fr Inst—July, 1905. No. 70843 D.

DISTRIBUTION.

Cables.

The Heating of Triple Underground Cables (Ueber die Erwarmung von Versellten Drefachkabeln in Erde Verlegt). Paul Humann. With tables and diagrams for computing the rise in temperature; comparing the computed results with experimental determinations. 4500 w. Elektrotech Zeitschr—June 8, 1905. No. 70970 B.

Conduits.

Underground and Submarine Conduits for Electric Wires. D. A. Harrington. An illustrated article, describing the solid system, and the drawing in system, and discussing the materials used, methods of construction, etc. 7000 w. Jour Assn of Engng Socs—May, 1905. No. 71091 C.

Converters.

How to start Rotary Converters. Arthur Wagner. Gives diagrams showing the connections for different methods employed, together with the various conditions under which they operate. 1000 w. Elec Jour—July, 1905. Serial. 1st part. No. 70810.

Extensions.

Extensions to Outlying Areas. A. B. Mountain. Read before the Incor. Munic. Elec. Assn. Considers the extensions of electrical mains beyond the municipal boundary barely remunerative. General discussion. 3000 w. Elect'n, Lond—June 30, 1905. No. 70713 A.

Rectifiers.

Mercury Arc Rectifiers. P. D. Wagoner. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Describes a rectifier consisting of a mercury-vapor arc., enclosed in an exhausted vessel, and its operation. 900 w. Engr, U. S. A.—July 1, 1905. No. 70591 C.

The Mercury Vapor Converter. P. H. Thomas. Explains the operation of the apparatus, and gives some of its applications. Ills. 1700 w. Elec Jour—July, 1905. No. 70807.

Switch Gear.

Colliery and Mining Switch Gear for High and Low Tension Alternating-Current Service. A. M. Randolph. Illustrates and describes a special line of switch gear developed by the British Westinghouse Co. 1500 w. Ir & Coal Trds Rev—June 30, 1905. Serial. 1st part. No. 70730 A.

Transformers.

Operation of Transformers at Varying Frequencies and Voltages. M. A. Sammett. Read before the Can. Elec. Assn. Considers characteristics expressing the effect of varying frequency and variable voltage on transformer operation. 5000 w. Elec Rev, N. Y.—July 8, 1905. No. 70664.

ELECTRO-CHEMISTRY.

Address.

The Electrochemical Industries of Niagara Falls. A review of the address of Francis A. J. FitzGerald at the Buffalo meeting of the Am. Chem. Soc. Discusses the electro-chemical products made at Niagara Falls. 3300 w. Elec-Chem & Met Ind—July, 1905. No. 70667 C.

Agriculture.

Agricultural Electro-Chemistry. Abstract of a lecture by M. Guarini, on the different applications of electro-chemistry to agriculture and to the industries connected therewith. 2000 w. Sci Am Sup—July 22, 1905. No. 70838.

Electric Furnaces.

Five Thousand Degress of Heat. Describes the action of the electric furnace and some of the uses to which it has been applied, especially the making of gems. Illustrates and describes the making of diamonds. 2000 w. Sci Am—July 29, 1905. No. 71079.

Electric Smelting.

The Present Status of the Electric Smelting of Iron and Steel (Ueber den Gegenwärtigen Stand der Elektrischen Eisen und Stahlerzengung). Dr. W. Borchers. A general review of the furnaces which have been actually employed in electric smelting, with data as to the cost of production. 3500 w. Stahl u Eisen—June 1, 1905. No. 70937 D.

Electrolysis.

The Relation Between Electrolytic Action and the Temperature of Electrodes (Uber Beziehungen Zwischen Electrolytischen Vorgangen und der Elektrodentemperatur). Wilhelm Moldenhauer. An exhaustive review of experiments upon a great variety of solutions at different temperatures. 10,000 w. Zeitschr f Elektrochemie—May 26, 1905. No. 70991 D.

Electro-Metallurgy.

The Commercial Development of Electro-Metallurgy. George E. Walsh. Shows how the electric furnace has made possible the production of certain metals at a cost that would make them commercially profitable. 2000 w. Min & Sci Pr—July 1, 1905. No. 70680.

ELECTRO-PHYSICS.

Electrons.

Problems and Conclusions in the Electron Theory (Ergebuisse und Probleme der Elektronentheorie). H. A. Lorentz. A general review of the theory of electrons and the observations upon which it is based, together with some of the influences upon molecular physics. Two articles. 10,000 w. Elektrotech Zeitschr—June 15, 22, 1905. No. 70973 each B.

Insulation.

Compressed Gas as an Insulator. Report of a lecture by Harris J. Ryan. Gives results of testing the dielectric strength of gases under pressure. Ills. 2000 w. Elec Jour—July, 1905. No. 70809.

Magnetization.

Magnetizing by Continuous and by Alternating Currents (Ueber die Magnetisierung durch Gleichstrom und durch Wethselstrom). E. Gumlich and P. Rose. With diagrams showing the difference in magnetizing action of the two kinds of currents, and the respective current consumption. 6000 w. Elektrotech Zeitschr—June 1, 1905. No. 70966 B.

Magnets.

The Properties of Magnets Made of Hardened Cast Iron. B. O. Peirce. Abstract of a paper presented before the Am. Acad. of Arts & Sciences. Reports results of experiments made to determine whether such magnets might be used as a substitute for special steel magnets. 2000 w. Elec Rev, N. Y.—July 15, 1905. No. 70756.

Radio-Activity.

Apparatus for Measuring the Quantity and Penetration of X Rays (Appareils de Mesure des Facteurs Pénétration et Quantité de Rayons X). G. Contremoulins. Describing the metroradioscope and the radiophotometer, for quantitative work with X rays. 1500 w. Comptes Rendus—July 3, 1905. No. 70926 D.

Resistance.

The Variation of Electrical Resistance in the Contact of Carbon and Cast Iron. Eric Schoenau. Reports investigations of the variations of the resistance of such contacts. 500 w. Elec Wld & Engr—July 15, 1905. No. 70759.

Thermo-Elements.

The Relation Between Temperature and Voltage in Thermo-Elements (Zusammenhang von Temperatur und Spannung bei Thermoelemente). Arthur Palme. Diagrams giving results of measurements upon couples of various materials. 1000 w. Zeitschr f Elektrotechnik—July 2, 1905. No. 70990 D.

GENERATING STATIONS.

Baku, Russia.

Power Transmission in the Naphtha District of Baku. A. Gradenwitz. Illustrated description of the electric power station erected near the Caspian Sea to furnish power for boring the naphtha wells and pumping. 1000 w. Engr, U S A—July 1, 1905. No. 70588 C.

Clyde.

The Clyde Valley Electrical Power Company, Limited. Gives a diagram showing the area covered, and an illustrated description of the Yoker generating station. 3000 w. Elec Engr, Lond—June 23, 1905. No. 70630 A.

Commutation.

Commutating Magnets for Continuous Current Dynamos (Ueber Kommutierungsmagnete für Gleichstrommaschinen). Robert Pohl. Describing the use of auxilary poles to prevent the sparking of the commutator. 3000 w. Elektrotech Zeitschr—June 1, 1905. No. 70967 B.

Costs.

Charges for Supply from Combined Lighting and Traction Stations. John Hall Rider. Read before the Munic. Elec. Assn. Analyzes the cost of producing

We supply copies of these articles. See page 991.

electrical energy. Also short discussion. 2500 w. Elec Engr, Lond—July 7, 1905. No. 70788 A.

Notes on Costs and Tariffs for Electric Supply. Hamilton Kilgour. Read before the Incor. Munic. Elec. Assn. Shows a scientific basis for the determination of prices or discounts. Also discussion. 4800 w. Elect'n, Lond—June 30, 1905. No. 70711 A.

The Diversity Factor, and Its Influence on Motor Load Charges. A. M. Taylor. An investigation of the charges and how they are affected by diversity factor, motor load factor, etc. 2000 w. Elec Rev, Lond—June 23, 1905. No. 70633 A.

Dynamos.

Double-Field Dynamos for Single and Polyphase Currents (Doppelfeld Generatoren für Ein und Mehrphasenstrom). E. Ziehl. With diagrams of the windings, and a general discussion of the advantages of the improvement. 5000 w. Elektrotech Zeitschr—July 6, 1905. No. 70980 B.

The Leitner-Lucas Train-Lighting Dynamo. Illustrates and describes this system in its improved form, explaining its working and mechanical design. 2500 w. Elect'n, Lond—July 7, 1905. No. 70802 A.

The Lines of Force in Dynamos with Auxiliary Poles (Ueber Kraftlinien felder in Gleichstrommaschinen mit Wendepolen). S. Defris. An examination of the distribution of magnetism in continuous-current dynamos provided with auxiliary poles to prevent sparking. 2000 w. Zeitschr f Elektrotechnik—May 28, 1905. No. 70985 D.

Variable-Speed Dynamo. An illustrated account of the characteristics of this train-lighting dynamo, designed by Dr. E. Rosenberg, and its performance in actual service. Also editorial. 2500 w. Elec Wld & Engr—July 15, 1905. No. 70761.

Field.

The Electromagnetic Field in Dynamos (Das Elektromagnetische Feld in Maschinen). Fritz Emde. A mathematical study of the stationary magnetic field existing between the rotating and stationary members of a dynamo. Two articles, 6000 w. Zeitschr f Elektrotechnik—June 25, 1905. No. 70989 each D.

Hydro-Electric.

Modern Austrian Hydro-Electric Generating Plant. A. Steens. Illustrates and describes some interesting features of the central station in Zwolfmalgreien. A combination of an electric plant with water-works for the distribution of water for private use. 4000 w. Am Elect'n—July, 1905. No. 70603.

The Drammen Electricity Works (Elektrizitätswerk der Stadt Drammen). Fr. Thrue. A fully illustrated description of the hydraulic and electric features of the generating station at the Gravfos Falls, near Drammen, Norway. Two articles, 7000 w. Elektrotech Zeitschr—June 8, 15, 1905. No. 70969 each B.

The Sill Hydraulic Power Plant near Innsbruck. Franz Koester. Illustrated description of an interesting hydro-electric plant in the Tyrol. 1300 w. Eng Rec—July 1, 1905. No. 70601.

Isolated Plants.

The Economy of Isolated Plants. K. L. Aitken. Read before the Can. Elec. Assn. Deals with the smaller class of isolated plants which supplies light and power only to the building which contains the equipment. 3800 w. Can Elec News—July, 1905. No. 71040.

Load Factor.

Load Factor—Its Effect Upon an Electricity Station. Alex. Sinclair. Read before the Incor. Munic. Elec. Assn. An explanation of the effect of the load-factor upon the electricity supply works. Also discussion. 3300 w. Elect'n, Lond—June 30, 1905. No. 70709 A.

London.

The Supply of Electric Power to London. A Britton. A summary of the steps taken to unify the supply of current and electric power. 2500 w. Elec Wld & Engr July 8, 1905. No. 70692.

Marine Plants.

See Marine and Naval Engineering.

Municipal Station.

Proposed Municipal Electric Power Station for the City of New York. Drawings showing the general plan of the power plant, and discussing the general features; also reviewing the report of the Commission on Electric Lighting, submitted to the Mayor on June 19, 1905. 2500 w. Elec Rev, N Y—July 15, 1905. No. 70755.

The Supply of Electricity in Industrial Areas from a Municipal Point of View. William Hodgson. Read before the Incor. Munic. Elec. Assn. Discusses various phases of the problem. Brief general discussion. 2500 w. Elect'n, Lond—June 30, 1905. No. 70712 A.

Prepayments.

Electricity Supply by Free Wiring and Prepayment Meters. Alfred R. Sillar. Read before the Incor. Munic. Elec. Assn. Describes the author's method of introducing this system, the method of reading and collecting, etc. Short discussion. 3500 w. Elect'n, Lond—June 30, 1905. No. 70714 A.

Regulation.

On a Method of Potential Regulation Based on the Different Resistance Behavior of Carbon and Tantalum Lamps. A. E. Kennelly and S. E. Whiting. Shows

how the difference in the temperature resistance characteristics may be employed for regulating the electromotive force of a generator. 1500 w. Elec Wld & Engr —July 1, 1905. No. 70596.

Sparking.

External Causes of Sparking in Direct-Current Machinery. Sydney Woodfield. Discusses in detail the more common causes of sparking. 3200 w. Elec Rev, Lond—June 30, 1905. No. 70718 A.

Station.

An Australian Station Having Compound-Wound Dynamos Paralleled with Accumulators. E. Kilburn Scott. Brief illustrated description of the station and its equipment. 1000 w. Elec Rev, Lond —June 30, 1905. No. 70717 A.

Synchronizer.

Automatic Synchronizing of Generators and Rotaries. Paul MacGahan. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Describes a device recently perfected by the Westinghouse Electric & Mfg. Co., describing the actions of the various parts. Ills. 1500 w. Engr, U S A—July 1, 1905. No. 70590 C.

See also Street and Electric Railways.

LIGHTING.

Arcs.

The Beck Lamp (Die Beck Lampe). Oskar Arendt. Describing an improved form of arc lamp with inclined carbons of the flame type. 1000 w. Elektrotech Zeitschr—June 8, 1905. No. 70971 B.

The Phenomena of the Singing Arc (Sur les Phénomènes de l'Arc Chantant). A. Blondel. An examination of oscillograph curves from various singing arcs. 1200 w. Comptes Rendus—June 26, 1905. No. 70923 D.

Illumination.

Standards for the Illuminating Power of Arc Lamps (Normen für die Lichtstärke von Bogenlampen). Dr. Norden. Suggesting the establishing of standards for photometric comparison, in connection with the work of the German electrical societies. 2500 w. Elektrotech Zeitschr —June 22, 1905. No. 70975 B.

The Action of the Spherical Photometer (Die Vorgänge im Kugelphotometer). R. Ulbricht. Describing a form of photometer for the direct determination of the mean spherical illuminating power of electric lamps. 4000 w. Elektrotech Zeitschr—June 1, 1905. No. 70968 B.

Incandescent.

Some Notes on the Incandescent Lamp. A. B. Lambe. Read before the Can. Elec. Assn. Outlines the method of measuring, tabulating and comparing the light from incandescent lamps, and discusses their mechanical features. Ills. 5500 w. Can Elec News—July, 1905. No. 71039.

The Development of the Manufacture of the Edison Incandescent Electric Lamp—1881-1905. J. T. Marshall. A detailed account of the successive steps in the development of the Edison electric incandescent lamp from the period of its appearance to the present. Also discussion. Ills. 8500 w. Jour Fr Inst—July, 1905. No. 70842 D.

Mercury Lamp.

The Uviol Mercury Lamp (Die Uviol Quecksilberlampe). Dr. Axmann. Describing a mercury vapor lamp using a special glass permitting the passage of the ultra-violet rays, and especially adapted for medical purposes. 1200 w. Elektrotech Zeitschr—July 6, 1905. No. 70982 B.

Office Buildings.

The Lighting of Office Buildings. E. Leavenworth Elliott. Suggestions for adapting the illumination to the special needs. 1800 w. Cent Sta—July, 1905. No. 70690.

Street Lighting.

Street Lighting. E. E. Hoadley. Read before the Incor. Munic. Elec. Assn. Deals with the question from the point of view of a central-station engineer and the problems in towns of about 50,000 people. Shows that Nernst lamps can be used at less cost than incandescent gas lamps burning 4 cu. ft. of gas per hour. Also discussion. 6500 w. Elect'n, Lond—June 30, 1905. No. 70710 A.

Tantalum.

The Tantalum Lamp (Die Tantallampe). Otto Ely. A comparison of the performances of the carbon filament and the tantalum wire in incandescent electric lamps, with diagrams showing the current consumption and illuminating power. 1200 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70903 D.

MEASUREMENT.

Alternators.

The Testing of Alternators. Stanley P. Smith. Gives the results of a test made by the Behrend method, and the results of tests with unequal fields balanced, also results of a test with equal fields balanced, and gives conclusions as to the best methods. 1700 w. Elect'n, Lond—July 14, 1905. No. 70888 A.

Cables.

Measurements of the Capacity of Long Submarine Cables (La Mesure de la Capacité des Longs Câbles Sous-Marins). M. Devaux Charbonnel. The method consists in charging the cable in cascade with a condenser of known capacity; from which the capacity of the cable may be deduced. 1200 w. Comptes Rendus—June 13, 1905. No. 70922 D.

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Core-Loss.

A Method of Calculating the Core-Loss in Large Alternators. T. S. Allen. Explains a method of calculation which has been adopted by the Electrical Department of the Allis-Chalmers Co., and which gives very satisfactory results. 1400 w. Elec Wld & Engr—July 1, 1905. No. 70597.

Instruments.

The Computation of Revolving-Coil Measuring Appliances (Die Berechnung von Drehspul Messgeräten). F. Janus. Deriving formulas for the computation of the magnets, coils, and other portions of various measuring instruments. 3500 w. Elektrotech Zeitschr—June 15, 1905. No. 70974 B.

Iron Loss.

Notes on Iron Loss. F. Lydall. An account of experiments undertaken to ascertain how far the Steinmetz law held good with high densities. 1600 w. Elec Rev, Lond—June 23, 1905. Serial. 1st part. No. 70632 A.

The Measurement and Distribution of Iron Loss in Induction Motors (Messung und Trennung der Eisenverluste in den Asynchronen Drehstrommotoren). O. S. Bragstad. With diagrams to aid in the determination of hysteresis and eddy-current losses. 1800 w. Zeitschr f Elektrotechnik—June 18, 1905. No. 70988 D.

Losses.

The Distribution of Losses in Continuous-Current Dynamos (Zur Trennung der Verluste in Gleichstrommaschinen). W. Linke. With diagrams for practical use in dynamo testing. 1500 w. Elektrotech Zeitschr—June 29, 1905. No. 70979 B.

Magnetization.

Apparatus and Methods of Measurement of Coefficients of Magnetization (Appareil et Méthode de Mesure des Coefficients d'Aimantation). Georges Meslin. Describing the use of the torsion balance for determining magnetic coefficients. 1200 w. Comptes Rendus—June 26, 1905. No. 70924 D.

Meters.

Report of the Electric Testing Office (Bekanntmachung über Prüfung und Beglaubigungen durch die Elektrischen Prüfämter). A report of the electric testing department of the Reichsanstalt, authorizing the use of certain described electric meters in Germany. 6000 w. Elektrotech Zeitschr—June 29, 1905. No. 70977 B.

The Selection and Maintenance of Service Meters. William Bradshaw. On the mechanical construction, electrical characteristics, capacity and maintenance of meters. Ills. 2500 w. Can Elec News—July, 1905. No. 71043.

Recorder.

Electric Spark Recorder. F. W. Springer. Illustrated description of an apparatus which has been in use six years and proven successful. 2000 w. Elec Wld & Engr—July 1, 1905. No. 70594.

Resistances.

The Measurement of Low Resistances. Lancelot W. Wild. Describes a little-known method of measuring low resistances that combines the sensibility of the differential galvanometer method with the highest degree of accuracy, it is claimed. 1000 w. Elect'n, Lond—July 14, 1905. No. 70887 A.

Voltameter.

An Iodine Titration Voltameter. D. Albert Kreider. Gives experimental investigations with a titration voltameter, showing the accuracy may be depended upon to about one part in ten thousand. 3000 w. Am Jour of Sci—July, 1905. No. 70811 D.

MOTORS.

Crane Motors.

Calculations for the Shaft, Gear and Bearings of Crane Motors. George J. Leire. Gives an example and illustrates the use of the table and diagrams given in the method of calculation. 900 w. Mach, N Y—July, 1905. No. 70585 C.

Diagram.

The Construction of the Current Diagram of a Polyphase Induction Motor (Konstruktion des Stromdiagrammes eines Mehrphasen Asynchronmotors). T. Rosskopf. Brief description, with geometrical proof. 600 w. Zeitschr f Elektrotechnik—June 11, 1905. No. 70987 D.

Induction Motors.

Auto-Starter for a 1,400-Horse-Power Induction Motor. Brief illustrated description of an apparatus manufactured by the Westinghouse Co. 900 w. Sci Am Sup—July 15, 1905. No. 70749.

Notes on the Induction Motor as Generator. T. P. E. Butt. Gives results of a test made by the writer, explaining the action of asynchronous generators. 3000 w. Jour S African Assn Engrs—May, 1905. No. 70626 F.

Notes on the Polyphase Induction Motor. H. A. Burson. Read before the Can. Elec. Assn. Considers the characteristics, the various types, and the classes of work to which each is suited. 1500 w. Can Elec News—July, 1905. No. 71041.

The Starting of Induction Motors. Frank Lewis. Illustrates and describes the selective winding designed by the writer, which does not require a complicated switchgear and which fulfils the conditions for efficient selection. 2000 w. Elec Rev, Lond—June 30, 1905. No. 70716 A.

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Shunt Motors.

Shunt Motors for Electric Cranes. Claude W. Hill. Points out the advantages the shunt motor offers for driving the hoisting gears of cranes, more especially when the gears are remote from the controller. 700 w. Elec Rev, Lond—July 14, 1905. No. 70884 A.

Winding.

Notes on the Winding of Polyphase Rotors. Leonard J. Pumphrey. Deals with the design of windings for three-phase motors. 1200 w. Elec Rev, Lond—July 14, 1905. No. 70885 A.

TRANSMISSION.

Italy.

The Electric Transmission of Energy at 40,000 Volts between Gromo and Nembro (Transport d'Energies à 40,000 Volts entre Gromo et Nembro). L. J. Sidler. An illustrated description of the transmission portion of the Gromo hydro-electric plant, in northern Italy. 2500 w. 1 plate. Génie Civil—July 8, 1905. No. 70921 D.

Lightning Arresters.

Correct Position of Lightning Arresters in the Circuit and the Effect of Choking Coils. F. Neeson, in *Elektrotechnische Zeitschrift.* An account of some tests carried out at the Reichsanstalt for the purpose of determining whether a lightning arrester is most effective when connected as a shunt to the circuit, or when in series. The results point uniformly to the latter. 1200 w. Elec Engr, Lond—June 25, 1905. No. 70631 A.

Lines.

Regulation and Efficiency of Transmission Lines. Harold Pender. Calls attention to an error in the table found on page 126 of Foster's "Electrical Engineer's Pocket Book." 700 w. Elec Wld & Engr—July 1, 1905. No. 70595.

Long Distance.

A Long Distance Electric Power Transmission Line in Nevada. E. Prince. Brief description of a line to the Goldfield and Tonopah mining districts of Nevada and the interlying towns, now being constructed. 900 w. Eng News—July 6, 1905. No. 70616.

Niagara Power.

Transmission of Niagara Power to Toronto. The present article gives an illustrated description of the steel towers which are to carry four circuits for the transmission of 40,000 h. p. at 60,000 volts. 1500 w. Elec Wld & Engr—July 1, 1905. Serial. 1st part. No. 70593.

MISCELLANY.

Appliances.

Electric Appliances. A. Balsley. Gives experiences gained from the practical operation of electrical appliances, and apparatus, such as lamps, batteries, dynamos, rotaries and frequency changes. 2800 w. Pro S & S W Ry Club—April, 1905. No. 70815 C.

Brazil.

Electricity in Brazil. W. Whyte Gailey. Information concerning this country and the character of the electrical work. 2200 w. Elec Rev, Lond—June 23, 1905. No. 70634 A.

Coast Defense.

Electricity in the Coast Defense. Illustrated description of the school at Fort Totten, N. Y., where officers of the artillery of the United States Army are taught how to use electricity in war. 1500 w. Elec Rev, N Y—July 29, 1905. No. 71105.

Lightning.

Modern Lighting Conductors. Killingworth Hedges. A discussion of the best method of protection, reviewing also the opinions of other writers. Ills. Also discussion. 3000 w. Jour Soc of Arts—May 26, 1905. No. 70025 A.

The Lightning Danger in Germany (Die Blitzgefahr in Deutschland). O. Steffens. A review of reports of lightning from various parts of Germany comparing these with the record of sunspots. 6000 w. Elektrotech Zeitschr—June 8, 1905. No. 70972 B.

Mexico.

Electric Power Developments in Mexico. Francis O. Blackwell. An illustrated article reviewing the progress in power developments. 4000 w. Cassier's Mag—July, 1905. No. 71025 B.

Portland Exposition.

Electrical Features of the Portland Exposition. An illustrated article describing the electrical service. 700 w. Elec Wld & Engr—July 22, 1905. No. 71047.

INDUSTRIAL ECONOMY

Coal Carrying.

A Great Coal Carrying Fleet. Remarks on the disappearance of the old steam collier fleet of the N. Atlantic coast, and the change to schooner-rigged barges, towed by large tugboats. 1500 w. Naut Gaz—July 13, 1905. No. 70801.

Combinations.

Trade Selling Combinations (Les Comptoirs de Vente en Commun). A

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comparative study of the trade combinations known as Trusts in America, Cartells in Germany, and Comptoirs in France. 2000 w. Génie Civil—June 17, 1905. No. 70916 D.

Cost Keeping.

Cost Keeping in General Construction and Contract Work. A. W. Buel. The third and concluding paper discusses the elements of an improved cost-keeping system for an extensive contracting company. 3500 w. Engineering Magazine—August, 1905. No. 71059 B.

Depreciation.

The Depreciation Problem. John L. Bronson. Discusses briefly methods of getting an idea of the depreciation of a plant, and the problem of reconstruction. 1200 w. Cassier's Mag—July, 1905. No. 71026 B.

Education.

The Academic Side of Technical Training. Abstract of an address delivered before the University College, London, Union Society, by Dr. Alex. B. W. Kennedy. Review of engineering training, with suggestions. 4000 w. Elect'n, Lond—June 30, 1905. No. 70715 A.

The Navy Wireless School. Walter L. Beasley. An illustrated account of the wireless school established at the Brooklyn navy yard for training young sailors for this branch of service. 1000 w. Sci Am—July 15, 1905. No. 70745.

Export Trade.

Engineering Exports of Britain, Germany, and the United States. W. Pollard Digby. The third and concluding article discusses the trade of the West Indies and adjacent countries, British America, South Africa, and Australasia, in its relation to Great Britain. 3000 w. Engineering Magazine—August. 1905. No. 71056 B.

Labor.

The Labor Problem from an Engineer's Point of iew. William W. Bird. A lecture, considering the labor problem as a problem of forces, and discussing these forces in detail. 4500 w. Jour Worcester Poly Inst—July, 1905. No. 70806 C.

Laboratory.

The New Mechanical Laboratory of the Dresden Polytechnic (Les Nouveaux Laboratoire de Mécanique de l'Ecole Technique Supérieur de Dresde). With plans and elevations of the buildings, and a general account of the equipment. 2500 w. 1 plate. Génie Civil—July 1, 1905. No. 70920 D.

Mining Investments.

A Plea for Sane Mining Finance and More Conservative Mining Investments. Harry J. Newton. A discussion of the outlook in mining investment business. 3000 w. Min Wld—July 22, 1905. No. 71005.

New Ideas.

The Suggestion System. H. F. J. Porter. Explains a method whereby new ideas are encouraged, and their value estimated, and recommendation for adoption presented to the management of shops. Ills. 2000 w. Cassier's Mag—July, 1905. No. 71029 B.

Opportunities.

Opportunities for Engineering Graduates in the Government Service. John F. Hayford. Read before the Soc. for the Pro. of Engng. Ed. Deals with the opportunities for graduates in civil, mechanical, electrical and mining engineering. 2400 w. Eng News—July 13, 1905. No. 70740.

Works Management.

A Combined Bonus and Premium System. Hugo Diemer. Describing the practical introduction of the system in a stronghold of trades unionism. 3000 w. Engineering Magazine—August, 1905. No. 71060 B.

The Higher Law in the Industrial World. H. F. J. Porter. A consideration of the commercial and industrial value of altruistic principles as applied in manufacturing establishments. 4000 w. Engineering Magazine—August, 1905. No. 71054 B.

MARINE AND NAVAL ENGINEERING

Battleship.

The Japanese Battleship "Katori." Gives a description of this vessel, being built in England, and of its equipment. 1500 w. Engng—June 30, 1905. No. 70622 A.

Canoes.

Folding Canoes and Jointed Ores. Emile Guarini. Illustrates and describes a portable, collapsible boat exhibited at Brussels. 1000 w. Sci Am—July 8, 1905. No. 70621.

Coal Carrying.

See Industrial Economy.

Cruiser.

H. M. First-Class Cruiser Achilles. Illustration, brief description, and remarks concerning this recently launched vessel. 700 w. Engr, Lond—June 23, 1905. No. 70644 A.

The French Cruiser Leon Gambetta. Describes this first of three armored-cruisers for the French fleet. 700 w. Engr, Lond—July 7, 1905. No. 70794 A.

Destroyers.

The Destroyer "Huszar." Description of this destroyer built for the Austro-Hungarian Government, with comparison with destroyers built for the Japanese Government. Ills. 1100 w. Engng—June 23, 1905. No. 70639 A.

Dry Docks.

See Civil Engineering, Waterways and Harbors.

Electric Plants.

Electricity on Shipboard (Einiges über Schiffselektrotechnik). C. Schulthes. An examination of the electrical requirements on shipboard, with description of generators, wiring systems, etc., adapted for marine service. Serial. Part I. 3500 w. Glasers Annalen—July 1, 1905. No. 70931 D.

Explosion.

Steam-Pipe Explosion on Board the Steamship "Orizaba." Report of Board of Trade inquiry, by David G. Watson and Thomas Carlton. The explosion occurred on Nov. 25, 1904. Ills. 4500 w. Mech Engr—July 1, 1905. No. 70707 A.

Liners.

The Mammoth Cunard Liners. Describes interesting features of the two turbine-driven Cunarders now under construction, giving a cross-section. 1600 w. Sci Am—July 22, 1905. No. 70832.

Liquid Fuel.

Recent Developments in the Application of Liquid Fuel to Marine Boilers. A report of some highly successful tests carried out in England with various types of burners. Ills. 1500 w. Sci Am Sup—July 8, 1905. No. 70625.

Motor Boats.

Modern Motor Boats (Moderne Motorboote). Photographs and details of some recent motor boats of American and Swiss design. 1800 w. Schweiz Bauzeitung—May 27, 1905. No. 70952 B.

Motor Boats. Dr. William F. Durand. States the problems of this class of boats, especially considering the motive power plant, its design, character and installation. Ills. 3000 w. Marine Engng—July, 1905. Serial. 1st part. No. 70608 C.

Resistance.

Laws of Variation of Resistance of Ships. D. W. Taylor. Discusses the model basin experiments, and other calculations for obtaining an approximate method or formula of value in practice, representing the resistance of a vessel. 2800 w. Marine Engng—July, 1905. No. 70609 C.

Salvage.

The Salvage of the Dredger "Walter Bibby." An illustrated account of one of the most difficult salvage operations yet conducted. 1000 w. Engng—July 14, 1905. No. 70895 A.

Steamer.

The Fall River Line Steamer Providence. Illustrated detailed description of this new ship, the most luxuriously fitted of the Fall River Line. 1500 w. Marine Engng—July, 1905. No. 70607 C.

Steamship Machinery.

The Machinery of the Great Northern Steamship Dakota. Illustrated detailed description. 1100 w. Marine Engng—July, 1905. No. 70610 C.

Submarines.

The Loss of Submarine A 8. Extracts from the *Western Morning News* in the account of the trial of the survivors of this submarine which sank suddenly near Plymouth Sound on June 8. Also editorial. 7200 w. Engr, Lond—June 23, 1905. No. 70643 A.

Turbine Steamer.

The Turbine-Driven Isle of Man Steamer "Viking." An illustrated detailed description of an interesting vessel in which the Parsons steam-turbine takes the place of the reciprocating engine. 1500 w. Engng—June 30, 1905. No. 70725 A.

Vibrations.

The Schlick Pallograph. Dr. Alfred Gradenwitz. Illustrates and describes an apparatus for measuring and registering the vibrations of steamers. 2300 w. Sci Am Sup—July 15, 1905. No. 70748.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Air-Cooled Motors in Principle and Practice. Herbert L. Towle. Discusses the details of this class of motors, the advantages, requirements, devices used, &c. 1300 w. Automobile—July 20, 1905. Serial. 1st part. No. 70844.

Climax.

The 14 H. P. Climax Car. Illustration and brief description of the principal features, and the working. 1400 w. Autocar—June 24, 1905. No. 70628 A.

We supply copies of these articles. See page 991.

Country Work.

Motor Cars for Country House Work. F. Strickland. A study of the requirements for such service. 2000 w. Autocar—July 15, 1905. No. 70877 A.

De Dietrich.

The 1905 De Dietrich Cars. Illustrates and describes the new models, of which there are four distinct types. 1600 w. Auto Jour—July 1, 1905. Serial. 1st part. No. 70706 A.

Light Car.

James and Browne Two-Cylinder Light Car. Illustrates and describes a motor car of British make, with combined engine crank chamber and gear box set below the floor level in the center of the frame. 1000 w. Autocar—July 1, 1905. No. 70704 A.

Motor Car.

Steam Motor Car for the Glasgow & Southwestern Ry. Illustrates and describes a motor car in which the engine is detachable from the car. 300 w. Eng News—July 20, 1905. No. 70825.

Motor Troubles.

What to Do When the Motor Balks. A. D. River. The first of a series of articles giving practical suggestions for tracing up troubles on the road and directions for applying the proper remedies. 1500 w. Automobile—July 13, 1905. Serial. 1st part. No. 70737.

Motor Vehicles.

Commercial Motor Vehicles. J. F. Gairns. The present article discusses steam motor vehicles adapted for the carriage of goods. Ills. 4800 w. Cassier's Mag—July, 1905. Serial. 1st part. No. 71027 B.

New Car.

The 18-24 B. A. C. S. Car. Illustrations and general details of a new car, built in France, for the British Automobile Commercial Syndicate. 900 w. Autocar—July 8, 1905. No. 70786 A.

Omnibuses.

English Motor Omnibuses for City and Country Use. Information concerning the motor omnibus traffic and its advantages, with illustrated descriptions of some of the vehicles in use in England. 4000 w. Sci Am Sup—July 29, 1905. Serial. 1st part. No. 71082.

Racing.

The Gordon-Bennett Cup in 1905 (La Coupe Gordon Bennett in 1905). F. Drouin. Describing especially the machines entering in the French preliminary trials. 2500 w. Génie Civil—July 1, 1905. No. 70919 D.

The Gordon-Bennett Race. Statistics of this race, with revised times of the competitors, the average speeds, &c. Ills. 2000 w. Auto Jour—July 15, 1905. No. 70874 A.

Rexette.

A Two-Cylinder Engined Rexette. Gives plan and elevation view of the chassis of a new machine, with description. 700 w. Autocar—July 15, 1905. No. 70876 A.

Runabout.

Construction and Operation of a Home-Made Steam Runabout. H. D. Penney. Illustrated description of a vehicle made by the writer, and its operation. 2800 w. Automobile—July 13, 1905. No. 70738.

Touring Car.

Pope-Tribune 12-H. P. Light Touring Car. Illustrated detailed description of the Pope-Tribune Model IV. 1200 w. Automobile—June 29, 1905. No. 70554.

The Tourist Trophy, and Its Value to Car Owners. Discusses the subject in a general way, showing how far the rules will secure the desired result, giving suggestions. 3800 w. Auto Jour—July 15, 1905. Serial. 1st part. No. 70875 A.

COMBUSTION MOTORS.

Gas Engines.

High Power Gas Engines in Electric Power Plants of German Ironworks. Frank C. Perkins. Brief illustrated descriptions of a 1,200-H.-P., double-acting, tandem gas engine, driving generator at the Dillingen iron-works, and a 650-H.-P. gas engine at the Holberger iron-works. 1200 w. Elec Rev, N Y—July 1, 1905. No. 70571.

Modern Gas and Oil Engine Practice. Horace Allen. States the necessary conditions of internal combustion motors, which have so successfully been fulfilled; reviews the history, and describes the practice followed in different types. Ills. 2500 w. Mech Engr—July 15, 1905. Serial. 1st part. No. 70879 A.

Some Modern Gas Engines. Illustrates and describes engines manufactured in Great Britain. 7500 w. Engr, Lond—June 23, 1905. Sup. No. 70645 A.

The Growth of Large Gas Engines on the Continent. Rodolphe E. Mathot. An illustrated review of the development, especially the improvements introduced during the past five or six years. 13500 w. Inst of Mech Engrs—June, 1905. No. 70646 D.

The Influence of Self-Acting and Controlled Admission Valves upon the Performance of Gas Engines (Der Einfluss Selbsttätiger und Gesteuerter Einlassventile auf Leistung und Verbrauch von Explosionsmotoren). K. Fehrmann. Discussing especially the influence of increased speeds upon the behaviour of uncontrolled valves. 2500 w. Zeitschr d

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Ver Deutscher Ing—July 1, 1905. No. 70912 D.

The Mechanical Efficiency and Indicated Power of Gas Engines (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gas Maschine). Hugo Guldner. A discussion of the basis on which the mechanical efficiency should be computed, taking the compression resistance into consideration. 1500 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70908 D.

The Mees Gas Engine (Die Gasmaschine Bauart Mees). Fr. Freytag. Describing an improved gas engine in which the speed regulation is effected by a combination of the methods of varying the mixture and the volume of the charge. 3000 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70902 D.

Gas Power.

Electric Power from Blast Furnaces. P. Eyermann. Discusses the advantages of engines, driven by blast furnace gas, and the details of operation of such a plant. 2200 w. Ir Age—July 20, 1905. No. 70804.

Gas Producers.

European Gas Producers. Emile Guarini. Describes poor gas and its use for fuel; gas producers that work under pressure, and those which work by suction; and poor gas motors. Ills. 8000 w. Jour of Elec—July, 1905. No. 71038 C.

Internal Combustion.

Explosion Motors (Die Explosionsmaschine). L. Dölling. A general review of the development of the internal-combustion motor and its applications to power generating stations. Three articles. 7500 w. Zeitschr f Elektrotechnik—June 4, 11, 18, 1905. No. 70986 each D.

Internal Combustion Engines. Dugald Clerk. The first of a series of articles explaining the fundamental principles of these engines, and reviewing the history of their development. 5000 w. Jour Soc of Arts—July 7, 1905. Serial. 1st part. No. 70800 A.

Petrol Engines.

The White and Poppe Petrol Engines. Describes the accurate working methods in the manufacture of this engine, the extent of the interchangeable system, &c. Ills. 1700 w. Autocar—July 1, 1905. No. 70705 A.

HEATING AND COOLING.

Central Stations.

Notes on the Design of Central-Station Hot-Water-Heating Systems. J. D. Hoffman. Discusses the details of a typical design. 5000 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70824 C.

Combination Plant.

Baltimore Refrigerating and Heating Co.'s Plant. Illustrates and describes a combination power, heating, refrigerating and electric lighting service. 7800 w. Ice & Refrig—July, 1905. No. 70580 C.

District Heating.

District Heating. Gives some important data reported to the Nat. Elec. Lgt. Assn. in regard to heating in connection with electric lighting, and discusses the service generally. 2200 w. Eng Rec—July 15, 1905. No. 70784.

Drying.

Drying by Steam, Hot Air, and Waste Gases. Hugh J. Barron. A discussion of the best practice for drying various materials. 3300 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70823 C.

Dust.

Dust Deposition in Relation to the Heating of Buildings. W. F. Barrett. Extract from a paper recently read before the British Inst. of Heat. & Ven. Engrs. Discusses the cause of dust deposits on room walls. 1300 w. Met Work—July 22, 1905. Serial. 1st part. No. 70854.

Hot Air.

Possibilities in Heating with Hot Air. R. S. Thompson. Presents arguments in proof of the economy of this system of heating. 2500 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70822 C.

Hot Water.

Residence Heating by Direct and Indirect Hot Water. E. F. Capron. Describes a heating apparatus installed in a three-story and basement brick residence, having exposure on all sides, with no protection from surrounding buildings. Ills. 500 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70819 C.

Radiation.

Sheet Metal Radiation. H. W. Nowell. Brief article, presenting the merits of sheet metal radiation. 700 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70820 C.

Refrigeration.

Test of an Absorption Refrigerating Machine (Untersuchung einer Absorptions-Kältemaschine). R. Habermann. With diagrammatic illustration of the machine and complete tabulated data and results of test and heat balance. 4000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70905 D.

Regulations.

German Heating and Ventilating Laws. Charles F. Hauss. Gives the German law covering all work in heating and ventilation. 2000 w. Met Work—July 1, 1905. Serial. 1st part. No. 70553.

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Rotary Furnace.

Heating a Church at Martin's Ferry, Ohio. An analysis of a rotary warm air furnace heating system. Ills. 2700 w. Met Work—July 22, 1905. No. 70853.

School Houses.

The Warming and Ventilation of School Houses (Ueber die Heizung und Lüftung von Schulhäusern). P. Hase. With graphical diagrams for computing the proportions of apparatus. 5000 w. Gesundheits-Ingenieur—June 20, 1905. No. 70995 B.

Steam Economy.

Some Observations on Steam Economy in Connection with the Heating Trade. O. M. Row. Read before the Inst. of Heat. & Ven. Engrs. Remarks on economy in the initial raising of the steam, and a discussion of the economical utilization. 6000 w. Plumb & Dec—July 1, 1905. No. 70727 A.

Steam Heating.

Steam Heating Principles. Prof. William J. Baldwin. A lecture before the Brooklyn Polytechnic Institute's College of Arts and Engineering. Discusses the history and practice of steam heating and defines the underlying principles. 2500 w. Dom Engng—July 1, 1905. Serial. 1st part. No. 70560.

Ventilation.

Experimental Researches upon the Flow of Air in Pipes (Versuche über den Widerstand bei Bewegung der Luft in Rohrleitungen). H. Rietschel. An exhaustive report of tests made at the Government shipyards at Kiel. 12000 w. Gesundheits-Ingenieur—July 1, 1905. No. 70998 B.

Flow of Air in Metal Pipes. J. H. Kinealy. Gives formula and table with information. 2000 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70821 C.

HYDRAULICS.

Centrifugal.

Centrifugal Pumps for High and Low Heads (Hoog en Laagdruk Centrifugaalpompen). Chr. Eeuwens. With sections and details of a number of recently designed pumps, including direct-driven multiple-stage pumps for high-pressure service. 4000 w. 2 plates. De Ingenieur—June 17, 1905. No. 71051 D.

Pumping Engine.

72,000,000-Gallon Pumping Engine at Boston, Mass. Illustrated detailed description of a pumping engine believed to be the largest reciprocating pump in the world, recently installed for the Boston Main Drainage Works, of the Sewer Division. 2000 w. Eng News—July 6, 1905. No. 70614.

Pumps.

Modern Duplex, Flywheel and Turbine Pumps (Neuere Duplex-Pumpmaschinen, Schwungrad-Pumpmaschinen, und Turbinenpumpen). Otto H. Mueller. A critical comparison of modern large pumping machines of the several types, with details of construction and data of performances. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70900 D.

Westinghouse Compound Pump. F. H. Parke. Illustrated description of the design and operation. 1600 w. R R Gaz—Vol. XXXVIII., No. 26. No. 70550.

See Civil Engineering, Water Supply.

Pump Tests.

Test of a High-Speed Rotary Pump (Versuche mit Einer Schnellaufenden Kapselpumpe). O. Kammerer. The pump was of the rotary piston type, directly driven by an electric motor, and the results of the test are given in graphic and tabular forms. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70907 D.

Valves.

The Gutermuth Patent Valve. Illustrated description of a simple and novel valve for pumps, compressors, blowing engines, &c. 1200 w. Ir Age—July 6, 1905. No. 70561.

Valves (Ventile). H. Raschen. A discussion of the unequal wear upon lift and check valves, due to the oblique flow of the fluid, with suggestions to obviate this action. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70906 D.

Water Power.

Formulas and Computations for Horse-Power Value of Streams. W. L. Church. The object of the paper is to derive formulas for the rapid estimate of the discharge value of a given drainage area, and to illustrate and simplify the method of computation of the value of a drainage area in connection with partial storage and steam auxiliary. 3000 w. Eng Rec—July 1, 1905. No. 70600.

The Hydraulic Power Plant on the Sill near Innsbruck (Die Wasserkraftmaschinen der Sillwerke bei Innsbruck). Andreas Stamm. An illustrated description of the hydraulic portion of the hydro-electric station supplying the city of Innsbruck. Pelton wheels are used. 2500 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70901 D.

The Industrial Economy of Water Power (L'Economie Industrielle des Forces Hydrauliques). E. F. Cote. An exhaustive discussion of the economics of water power, with especial reference to controlling legislation in France. 10000 w. Mem Soc Ing Civ de France—May, 1905. No. 70932 G.

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MACHINE WORKS AND FOUNDRIES.

Annealing Furnaces.

Coal-Dust Firing as Applied to Annealing Furnaces. Illustrates and describes annealing furnaces fitted with the Schwartzkopff system of coal-dust firing, and states results. 1000 w. Ir & Coal Trds Rev—June 23, 1905. No. 70647 A.

Automatic Machinery.

Compressed Air Marking Machine. H. J. White. Drawings and description, explaining operation. 900 w. Am Mach—Vol. 28, No. 29. No. 70817.

Casehardening.

Casehardening. David Flather. Read before the Cycle Engrs.' Inst., Birmingham, Eng. States the advantages sought in this process, and reviews the methods. 7500 w. Mech Engr—June 24, 1905. No. 70629 A.

Castings.

Cored Work in Aluminium Casting. Walter J. May. Suggestions for the casting of aluminium and its alloys. Ills. 900 w. Prac Engr—July 14, 1905. No. 70878 A.

The Production of Homogeneous Steel Castings Free from Internal Stresses (Ueber die Mittel zur Erzielung Dichter und Spannungsfreier Stahlformgusstücke). L. Treuheit. Discussing methods of moulding and pouring steel castings so as to avoid the production of blowholes and cooling stresses. Serial. Part I. 1800 w. Stahl u Eisen—June 15, 1905. No. 70941 D.

Chains.

Chain-Making by Electric Welding. Andris-Jochams. Illustrated description of the method of making chain by the Giraud process, stating the advantages of electric welding, and giving information regarding cost and quality. 3000 w. Ir Age—July 13, 1905. No. 70731.

Cranes.

10-Ton Electric Overhead Traveller at the Liége Exhibition. Illustrated detailed description, showing the use of three-phase current by placing a motor-generator on the crane. 800 w. Engng—July 14, 1905. No. 70896 A.

Cutting Speeds.

Cutting Speeds for Shapers and Slotting Machines. Frank B. Kleinhans. The first of an article in three parts. Explains the four ways of obtaining the quick return motion for shapers and slotting machines, investigating, in the present number, the cutting speed of the tool on a slotting machine. 1200 w. Mod Mach—July, 1905. Serial. 1st part. No. 70563.

Electric Driving.

Individual vs. Belt Drive in Electrically Operated Shops. Putnam A. Bates. An illustrated article discussing some mistakes made in installing electric apparatus, and the advantages of the individual motor drive. 1800 w. Am Elect'n—July, 1905. No. 70604.

Recent Machine Tools with Electric Driving (Neuere Werkzeugmaschinen mit Elektrischem Antrieb). Paul Möller. Illustrations of lathes, shapers, and drill presses arranged for direct electric driving; designed by the Oerlikon Works. 2500 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70904 D.

Estimates.

Estimating the Cost of Machine Work. J. A. Webster. Gives an analysis of the various operations to be performed in a machine taken as an example. Ills. 3500 w. Mach, N Y—July, 1905. No. 70586 C.

Factory.

The New Belting Factory of Charles A. Schieren & Company. Describes the details in the manufacture of belts, and gives an illustrated description of this New York factory. 1200 w. Am Mach—Vol. 28, No. 29. No. 70816.

Forming.

Improved Methods of Forming Hollow Vessels of Sheet Metal (Neuerung in der Ausbrauchung von Blechhohlkörpern). Karl Musiol. Illustrating workshop methods of rolling and forming sheet metal in the lathe, with the aid of moulds and patterns. 2000 w. Stahl u Eisen—July 1, 1905. No. 70944 D.

Foundry.

A Combined Baby Bessemer and Open Hearth Steel Foundry. Prof. Hermann Wedding. From a paper in *Verhandlungen des V. zur Befoerderung des Gewerbfleisses.* Explains the three lines along which the baby Bessemer process may be developed, and the details of operation, and gives illustrated description of the new plant of Otto Gruson, near Magdeburg. 2800 w. Ir Age—July 27, 1905. No. 71032.

Electricity in a Malleable Iron Foundry. H. P. Kernochan. Describes the electric equipment of the foundry of the Troy Malleable Iron Co., Watervliet, N. Y., for power and lighting. 1100 w. Elec Rev, N Y—July 8, 1905. No. 70663.

Guns.

How Gun-Barrels Are Straightened. William H. Avis. An explanation of the method of straightening, with illustrations. 1400 w. Am Mach—Vol. 28, No. 28. No. 70734.

Hopper.

Laying Out a Hopper for a Coal Chute by the Method of Triangulation. George Guntz. Drawings and description of the method used. 1000 w. Boiler Maker—July, 1905. No. 70652.

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Milling.

Semi-Automatic Hinge-Milling Machine. Francis W. Shaw. Illustrated detailed description of the machine and its operation. 1300 w. Am Mach—Vol. 28, No. 28. No. 70735.

Molding.

Making a Molder. H. M. Lane. Read before the Am. Found. Assn. Discusses present conditions and the training needed to make good molders. 2400 w. Foundry—July, 1905. No. 70861.

New Works.

Park Works, Huddersfield. Illustrated description of new gear-cutting works and their equipment. 2000 w. Engr, Lond—July 14, 1905. No. 70892 A.

Pipe Threads.

British Pipe Threads. W. H. Booth. An explanation of past and present practice in Great Britain. 2000 w. Am Mach—Vol. 28, No. 30. No. 71071.

Power Plant.

Power Plant at the Factory of Edward R. Ladew. Paul H. Grimm. Illustrated detailed description of the plant in the new factory at Glen Cove, N. Y., with report of one of the tests made periodically. 2400 w. Power—Aug., 1905. No. 71035 C.

Projectiles.

Coast Artillery Projectiles. Describes the function of armor-piercing projectiles, their design, manufacture, &c. 4800 w. Jour U S Art—May, 1905. No. 71031 D.

Soldering.

On Autogenous Lead Soldering. M. U. Schoop. Remarks on the methods of welding without any flux or any foreign metal that are of special value for storage battery factories. Especially considers the oxygen-hydrogen flame and its advantages. 1100 w. Elec-Chem & Met Ind—July, 1905. No. 70669 C.

Tool Room.

The Tool Room and Stock Room. Oscar E. Perrigo. Describes and illustrates the complete arrangements from the time stock is wanted until it is accounted for: the design, arrangement, and accounting systems. 5000 w. Ir Trd Rev—July 6, 1905. No. 70617.

Tools.

Some Corliss Engine Tools. Illustrates and describes some special appliances in use in the shops of the Hardie-Tynes Works, Birmingham, Ala. 1200 w. Am Mach—Vol. 28, No. 28. No. 70733.

Tool Shops.

Tool Shops of the Kawasaki Dockyard Company. Gompei Kuwada. An illustrated explanation of the outfit of machine tools and how they are arranged. 900 w. Am Mach—Vol. 28, No. 30. No. 71072.

Tool Steels.

High-Speed Tool Steels (Les Aciers à Outils à Coupe Rapide). J. Garnier. A description of the shop methods of preparing and using high-speed steels, with some data as to results. 2500 w. Génie Civil—June 17, 1905. No. 70914 D.

Waste.

Utilizing Unconsidered Trifles. From *English Mechanic and World of Science.* Directs attention to ways in which worn-out files, iron-gas-piping, old rails, and various other things may be utilized. 1200 w. Sci Am Sup—July 8, 1905. No. 70624.

Welding.

The Thermit Process in American Practice. Ernest Stutz. Read at the meeting of the Am. Soc. for Test. Materials. Some applications and the methods are explained. 2300 w. Ry & Engng Rev—July 22, 1905. No. 71008.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Abrasives.

The Industry of Abrasives and Corundum (L'Industrie des Abrasifs et le Corindon). A. de Romeu. A general review of the use of abrasive material in mechanical operations, with especial reference to the exploitation of deposits of corundum. 6000 w. Rev Gen d Sciences—June 15, 1905. No. 70993 D.

Alloys.

Alloys of Copper (Les Alliages de Cuivre). Leon Guillet. A general study of the present state of knowledge of ordinary and special bronzes and brasses. Serial. Part I. 3000 w. Génie Civil—June 24, 1905. No. 70918 D.

Brass.

The Dead, or Matt Dip for Brass. From the *Brass World.* The dead dip is the dip used to impart a satiny finish to brass. The method of producing this finish is described. 1200 w. Am Mach—Vol. 28, No. 29. No. 70818.

Cast Iron.

Hard Cast Iron. Henry Souther. Read before the Am. Soc. for Test. Materials. A brief account of trouble with very hard iron and the remedy. 800 w. Ir Tr Rev—July 13, 1905. No. 70736.

Methods for Testing Cast Iron. Richard Moldenke. Read before the Atlantic City meeting of the Am. Soc. for Test. Materials. Reviews the American and English pig iron specifications, and the method by which the metal is judged. 2400 w. Ir Age—July 13, 1905. No. 70732.

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Galvanizing.

Comparative Tests of Iron and Steel Articles Galvanized by the Hot and Cold Processes (Vergleichsversuche mit Eisen und Stahlwaren auf Heissem und Elektrolytischem Wege Verzinkt). Dr. Ignaz Szirmay. Results of tests upon sheet metal, wires, and pipe, showing the superiority of the electrical process. 1500 w. Zeitschr f Elektrochemie—June 2, 1905. No. 70992 D.

Heat Insulation.

Notes on Heat Insulation, Particularly with Regard to Materials Used in Furnace Construction. R. S. Hutton and J. R. Beard. A record of experimental investigations and results. Ills. 1500 w. Elec Rev, N Y—July 22, 1905. No. 71011.

Laboratory.

See Industrial Economy.

Steels.

Constitution and Properties of Aluminum Steels (Constitution et Propriétés des Aciers à l'Aluminium). Léon Guillet. A brief review of micrographic and mechanical examinations of steels containing up to 15 per cent. of aluminum. 1000 w. Comptes Rendus—July 3, 1905. No. 70927 D.

Constitution and Properties of Steels Containing Tin, Titanium, and Cobalt (Constitution et Propriétés des Aciers à l'Etain, des Aciers au Titane, et des Aciers au Cobalt). Léon Guillet. A brief note giving the mechanical properties of these alloy steels; at present of no practical value. 800 w. Comptes Rendus—June 26, 1905. No. 70952 D.

Special Steels. L. Guillet. Describes investigations made of certain ternary alloys and steels, particularly two grades, one containing only about 2% of carbon, and the other approximating to the eutectic and containing about 8% of carbon. 2300 w. Ir & Coal Trds Rev—June 30, 1905. No. 70729 A.

Testing.

The Testing Laboratory of the Conservatoire des Arts et Métiers (Organisation et Outillage du Laboratoire d'Essais du Conservatoire des Arts et Métiers). A. Perot. A general account of the new testing laboratory, and its relation to public and private industries. 4000 w. Mem Soc Ing Civ de France—May, 1905. No. 70935 G.

MEASUREMENT.

Friction.

The Friction of Ropes and Chains over Sheaves (Ueber Reibung von Seilen und Ketten auf den Triebscheiben). H. Herrmann. Deducing formulas for the computation of the sheave friction of winding cables, with especial reference to the Koepe system of mine hoists. 1000 w. Glückauf—June 30, 1905. No. 70948 D.

Harmonic Analysis.

The Harmonic Analysis of Valve Motions. Silvanus P. Thompson. An explanation of a very simple method. 800 w. Engng—July14, 1905. No. 70894 A.

Temperature.

Thermometers and Pyrometers, with Some of Their Industrial Applications. Abstract of a lecture by Robert Whipple, delivered before the Cleveland Inst. of Engrs., England, describing these instruments and the uses to which they are applied. Ills. 4000 w. Sci Am Sup—July 22, 1905. No. 70840.

Torsion Meter.

Torsion Meter for Recording the Horse Power of Steam Turbines. Illustrates and describes the apparatus invented by Archibald Denny and Charles Henry Johnson. 2000 w. Sci Am Sup—July 29, 1905. No. 71084.

POWER AND TRANSMISSION.

Compressed Air.

A High Speed Electrically Driven Compressor for Colliery Work. W. Reavell. Read before the S. Wales Inst. of Engrs. Illustrated description of a machine which can be directly driven by an electric motor and can be made in small units when desired. 3800 words. Ir & Coal Trds Rev—July 14, 1905. No. 71001 A.

Flow of Air in Pipes and the Transmission of Power by Compressed Air. Gives some theoretical considerations and calculations. 1200 w. Mines & Min—July, 1905. No. 70688 C.

Study of a Riedler Air Compressor. Arthur P. Hall. Explains the general working of the machine, and gives a series of cards taken under various conditions. 600 w. Compressed Air—July, 1905. No. 70796.

Suggestions for Running Air Compressors. M. W. Sherwood. Suggestions for setting and leveling, measuring and adjusting clearance, lubrication, etc. 12,000 w. Mines & Min—July, 1905. No. 70686 C.

Temperatures in Air and Ammonia Compressor Cylinders. Leicester Allen. A discussion of the indeterminate character of present information about compression temperatures. 3000 w. Engineering Magazine—August, 1905. No. 71057 B.

Conveying.

Coal Conveying Plant at the Metropolitan Electric Supply Co.'s Works. Illustrates and describes the methods of coal handling and firing employed at the Willesden Junction plant. 1500 w. Engng—July 14, 1905. No. 70898 A.

Power Plants.

Details of the Wanamaker Power

House, Philadelphia. Illustrated detailed description of arrangements for furnishing steam heat, electric light, pneumatic service, ventilation and refrigeration for one of the largest stores ever built. 2500 w. Eng Rec—July 22, 1905. Serial. 1st part. No. 71020.

Modern Power-Plant Design and Economics. Franz Koester. The first article discusses location, design of buildings, and general adaptability; comparing American and European practice. 3500 w. Engineer-the Magazine—August, 1905. No. 71058 B.

New Mechanical Plant of the Connecticut Hospital for the Insane. Illustrated detailed description of recent important changes in the mechanical plant, especially the new boiler-house, systems of piping, etc. 2200 w. Eng Rec—July 8, 1905. No. 70698.

The Gas Power and Heating Plant of the Atha Tool Co. J. R. Bibbins. Illustrated detailed description of a recently completed plant in Newark, N. J. 1800 w. Eng Rec—July 15, 1905. No. 70779.

Prime Movers.

The Choice of Prime Movers for Town Premises. W. H. Y. Webber. Discusses briefly the case of the power user in any town which is not given wholly to manufacturers. 2200 w. Gas Wld—July 15, 1905. No. 70870 A.

STEAM ENGINEERING.

Boilers.

Steam Boilers and Pipes. The first of a series of articles on essential points which must come before architects who are required to make provision for steam-producing plants in hospitals, asylums, schools, hotels, and other buildings. 2400 w. Builder—July 1, 1905. Serial. 1st part. No. 70701 A.

Boiler Scale.

The Use of Boiler Compounds. William M. Booth. From *The Chemical Engineer.* Considers the materials used, their effects, cost, and related matters. 1000 w. Eng News—July 27, 1905. No. 71069.

Chimneys.

The Design of Self-Supporting Steel Chimneys. John D. Adams. Considers the thickness of plates, the foundation, anchor-bolts, and tapering stocks. 2500 w. Eng News—July 20, 1905. No. 70827.

Discharge.

The Discharge of Hot Water from Tanks (Das Ausströmen Heissen Wassers aus Gefässmündungen). Dr. A. Fliegner. Deriving formulas for the flow of hot water, analagous to those for saturated steam. Two articles, 3000 w. Schweiz Bauzeitung—June 10, 24, 1905. No. 70954 each B.

Economy.

Suggestions for Steam Economy. Wm. McKay. Read before the Can. Elec. Assn. A discussion of some of the principles upon which economy in the use of steam depends. 2800 w. Can Elec News—June, 1905. No. 71042.

Engines.

Choosing an Engine for an Isolated Plant. H. S. Knowlton. Discusses points to be considered in the selection of engines for certain work 2700 w. Cassier's Mag—July, 1905. No. 71028 B.

Double-Piston Francois Engines. Gives particulars in regard to these engines, illustrated in a previous issue, and some results obtained with them. 2000 w. Engng—July 14, 1905. No. 70899 A.

Modern Economical Steam Engines and Turbines. Gives results obtained with some of the most modern engines and turbines. Ills. 1500 w. Engr, Lond—July 7, 1905. Serial. 1st part. No. 70791 A.

Robb-Armstrong Corliss Engines. Illustrates and describes the interesting features of these engines for slow and medium speeds. 1500 w. Can Engr—July, 1903. No. 70649.

750-Horse-Power Sulzer-Carels Engine. Illustrates and describes this horizontal compound condensing engine, shown at the Liége Exhibition. 1000 w. Engr, Lond—June 30, 1905. No. 70728 A.

16,000-Horse-Power Vertical Rolling-Mill Engines. Fully illustrated description of quite a departure in rolling-mill engines, believed to be the most powerful engine yet built for this purpose. 1600 w. Engng—June 23, 1905. No. 70637 A.

The Van den Kerchove Piston-Valve Engine. Illustrated description of a horizontal compound tandem steam engine with piston-valves, exhibited at the Liege Exhibition. 1500 w. Engng—June 30, 1905. No. 70724 A.

300 H.-P. Double-Piston (Francois Type) Compound Condensing Engine. Illustrations of an engine built by the Cockerill Company, and exhibited at Liége. 200 w. Engng—July 7, 1905. No. 70790 A.

Triple-Expansion Engine for Melbourne Corporation. Brief illustrated description. 1200 w. Elec Engr, Lond—June 30, 1905. No. 70719 A.

Explosion.

See Marine and Naval Engineering.

Feed-Water.

Some Phases of the Feed-Water Heater Problem. Walter E. Harrington. Urging the use of open feed-water heaters and presenting their advantages. 2800 w. St Ry Jour—July 22, 1905. No. 71013 C.

We supply copies of these articles. See page 901.

Flue-Gas.

Flue-Gas Analysis. F. H. Corson. Illustrates and describes apparatus for the analysis of the products of combustion, and its action. 1800 w. Elec Rev, Lond—July 14, 1905. No. 70883 A.

Fuel Tests.

Steam and Producer-Gas Tests of Coal. From the report on the tests of fuel made at St. Louis, by the U. S. Geol. Survey, giving table showing the comparative results of burning the various coals under the boiler and in the gas producer, and discussing the results. 1000 w. Eng & Min Jour—July 6, 1905. No. 70672.

Liquid Fuel.

See Marine and Naval Engineering.

Portable Engines.

Modern Portable Engines (Moderne Lokomobilen). Describing especially the portable and semi-portable engines of Wolf, of Magdeburg, which have given excellent economical performances. Three articles. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 27, June 3, 10, 1905. No. 70959 each D.

Steam Heating.

See Mechanical Engineering, Heating and Cooling.

Steam-Jacketing.

An Investigation to Determine the Effects of Steam-Jacketing upon the Efficiency of a Horizontal Compound Steam Engine. A. L. Mellanby. Read before the Inst. of Mech. Engrs. A report of experimental investigations and results. 1800 w. Engr, Lond—June 30, 1905. Serial. 1st part. No. 70880 A.

Superheating.

The Application of Superheated Steam to Piston Engines (Die Anwendung des Ueberhitzen Dampfes bei der Kolbenmaschine). Otto Berner. A study of various tests of engines using super-heated steam, forming the introduction to a general investigation of the subject. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70910 D.

Traps.

Modern Steam Traps. W. T. Edwards. Brief illustrated descriptions of modern types of steam traps, their methods of operation, and in some cases the manner of piping recommended to obtain the best results. 3500 w. Am Elect'n—July, 1905. No. 70606.

Turbines.

Efficiency Tests of a 400-Kilowatt Steam Turbine. Report of an acceptance test made at Providence, R. I., the method of testing following as closely as possible the standard of the A. S. M. E. 1000 w. Power—August, 1905. No. 71034 C.

Operating Features of the Vertical Curtis Steam Turbines. August H. Kruesi. Read before the Nat. Elec. Lgt. Assn. Discusses balance, bearings and lubrication, valves and governor, clearance, low and high pressure turbines, etc. Ills. 4000 w. Eng Rec—July 1, 1905. No. 70599.

The Parsons Steam Turbine on German Warships. Dr. Alfred Gradenwitz. Illustrates and describes particulars of the special arrangement chosen for two turbine-driven vessels. 1000 w. Sci Am Sup—July 8, 1905. No. 70622.

The Sulzer Steam Turbine (Dampf-Turbine von Gebrüder Sulzer). Description, with sectional view, of the new steam turbine designed by Sulzer Brothers, of Winterthur, Switzerland. 1800 w. Schweiz Bauzeitung—July 1, 1905. No. 70957 B.

Steam Turbines (Dampfturbinen). A. Wenger. Describing especially the steam turbines made by the Union Company, of Essen, with tabulated results of tests on a 50-horse-power turbine. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70909 D.

Valve Gear.

A New Corliss Valve Gear. F. Hardie Jeannin. Illustrates and describes a valve gear which relates to the class of steam engines using rotary exhaust valves, and rotary induction valves tripped by a suitable device and closed by means of a dashpot. 1500 w. Engr, U S A—July 1, 1905. No. 70589 C.

A Study of the Walschaert Valve-Motion. W. Pfitzner. Translated from the *Zeitschrift des Verein Deutscher Ingenieure*. The object of the study was to enable a valve motion to be designed on paper to a convenient scale and with sufficient certainty to render it unnecessary to test the design on a model. Ills. 2400 w. R R Gaz—Vol. XXXIX. No. 4. No. 71075.

Valve Leakage.

Steam Jackets and Valve Leakage. Prof. R. H. Smith. Reviews the report of the Steam Engine Research Committee of the Institution of Mechanical Engineers. 2700 w. Engr, Lond—June 23, 1905. No. 70641 A.

Waste Heat.

Method of Using Waste Heat. Howard N. Eavenson. Describes and illustrates the method of using waste heat from coke ovens for firing boilers at the No. 1 works of the Continental Coke Co. 1500 w. Mines & Min—July, 1905. No. 70682 C.

Water Gage.

Water Gage Glasses. J. Russell Mackay. Suggestions, based on long experience, for the renewal of water-gage glasses. Ills. 1200 w. Power—Aug., 1905. No. 71036 C.

We supply copies of these articles. See page 991.

MISCELLANY.

Aeronautics.

A New Aeroplane. Israel Ludlow. Illustrated description of the writer's design. 1500 w. Sci Am—July 15, 1905. No. 70746.

The Lebaudy Dirigible Balloon (Le Dirigeable Lebaudy). H. Julliot. A very complete account of the experiments made by Lebaudy with dirigible balloons since 1896, with detailed description of the 1904 model. 12,000 w. Mem Soc Ing Civ de France—May, 1905. No. 70936 G.

Air.

Atmospheric Friction as an Obstacle in Locomotion. Dr. A. F. Zahn. An illustrated description of experiments made to determine laws governing air resistance in moving bodies. 1500 w. Sci Am—July 22, 1905. No. 70835.

Low Temperatures.

Lord Blythswood's Liquid Air Plant for Experimental Work at Low Temperatures. Illustrates and describes apparatus for liquefying air and hydrogen gas. 1800 w. Sci Am Sup—July 2, 1905. No. 70836.

Telescope.

The Construction of a Silvered Glass Telescope, Fifteen and a Half Inches in Aperture, and Its Use in Celestial Photography. Henry Draper. Historical sketch, with illustrations. 6000 w. Sci Am Sup—July 29, 1905. Serial. 1st part. No. 71086.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

The Outlook for Coal-Mining in Alaska. Alfred H. Brooks. Information in regard to fuel-consumption in Alaska, the known coal-bearing rocks, the composition and fuel value of the coals, the coal-fields, etc. 6000 w. Map. Am Inst of Min Engrs—July, 1905. No. 71094 C.

Coal Carrying.

See Industrial Economy.

Coke.

By-Product Coke. Edwin A. Moore. Describes the method of manufacturing coke and the recovery of the by-products from the coal by means of the Otto-Hoffman system. Describes the plant of the Camden Coke Co., Camden, N. J. Ills. 8500 w. Mines & Min—July, 1905. No. 70687 C.

Coke Drawing.

A Machine for Drawing Coke from Bee-Hive Ovens. George T. Wickes. Illustrates and describes a machine put in operation in Uniontown, Pa., and reported to have met successfully all the tests to which it has been subjected. States its advantages. 2000 w. Am Inst of Min Engrs—July, 1905. No. 71100.

Colliery Practice.

The Price-Pancoast Colliery. George W. Harris. A description of this colliery, especially the surface arrangements and methods of preparing the coal for market in practice in the Lackawanna region. Ills. 2400 w. Eng & Min Jour—July 15, 1905. Serial. 1st part. No. 70752.

Disaster.

The United National Colliery Disaster. An illustrated article giving facts in regard to the explosion which occurred on July 11, and describing the equipment of the mine. 1800 w. Ir & Coal Trds Rev—July 14, 1905. No. 71002 A.

South Wales.

Geology of the South Wales Coal-Field. Information from the recently published Geological Survey Memoir. 5200 w. Engng—June 23, 1905. No. 70636 A.

COPPER.

Concentration.

Concentrating Methods at the Arizona Copper Company, Clifton, Arizona. A. Morrison. An illustrated article describing the methods. 900 w. Min Rept—July 6, 1905. No. 70679.

Deposits.

The Copper-Deposits of San Jose, Tamaulipas, Mexico. J. F. Kemp. Gives the situation and geology, describing the eruptive rocks which present rare types, and considering the methods whereby they could have been produced. 8000 w. Am Inst of Min Engrs—July, 1905. No. 71101 C.

Kedabeg Mines.

The Kedabeg Copper Mines. Gustav Köller. Gives location, history and description of these mines, the methods of working, treatment, etc. Ills. 13700 w. Inst of Min & Met—April 13, 1905. No. 70852 D.

Mines.

Foreign Copper Mines. Walter Harvey

Weed. A review of the world's supply of copper, showing that for many years to come the bulk must be derived from the United States and Mexico. Ills. 5500 w. Min Mag—July, 1905. No. 70856 C.

Prospects.

Copper Prospects. T. Lane Carter. Suggestions for prospecting for copper, the outfit needed, methods of determination, etc. 3500 w. Jour Chem, Met & Min Soc of S Africa—May, 1905. No. 70873 E.

Queensland.

Copper in Southern Queensland. Gives information concerning these deposits, describing the geology. 2300 w. Aust Min Stand—June 7, 1907. No. 70703 B.

Mount Molloy Copper Mine, North Queensland. An illustrated description of the mine and smelters. 2000 w. Queens Gov Min Jour—May 15, 1905. No. 70627 B.

Slag.

A Slag Calculation. Charles S. Palmer. Gives a method for the calculation of copper blast-furnace slag. 1000 w. Eng & Min Jour—June 29, 1905. No. 70581.

Utah.

The Cactus Copper Mine, Utah. S. F. Emmons. A brief description, giving the location, history, development, geology, etc. 2400 w. Ores & Metals—July 1, 1905. No. 70592.

GOLD AND SILVER.

Australia.

Mining in Western Australia. W. H. Burrell. Brief report of the condition of the mines of gold, silver and copper, the past production, and the future outlook. 1500 w. Mines & Min—July, 1905. No. 70685 C.

The Australian Northern Territory. John Plummer. Gives testimony of various explorers concerning valuable deposits of gold, silver, tin and other metals in this region. Ills. 1400 w. Min Wld—July 8, 1905. No. 70661.

Banket.

The Genesis of the Tarkwa Banket. Edward R. Schoch. An account of the theories advanced to explain these ore deposits in West Africa, with description of the gold occurrence. Also a short description of the Rhodesian conglomerate, and editorial. 3500 w. Eng & Min Jour—June 29, 1905. No. 70584.

Coeur d'Alene.

Ore Deposits of the Coeur d'Alene, Idaho. F. L. Ransome. Abstracted from Bul. 260 of the U. S. Geol. Survey. Describes the geology of this silver-lead region. 3000 w. Min & Sci Pr—July 8, 1905. Serial. 1st part. No. 70776.

The Coeur d'Alene District. F. L. Ransome. An illustrated article giving much information in regard to this lead-silver district in Idaho and Montana, which supplies more than one-third the lead mined in the United States. 2000 w. Min Mag—July, 1905. No. 70858 C.

Concentration.

Concentration of Silver-Lead Ores. V. F. S. Low. Abstract Trans. Aus. Min. Engrs. Applies to the concentration of the silver-lead ores of Broken Hill, N. S. W., especially to the ores in Block 10 mine. Ills. 3000 w. Min & Sci Pr—July 15, 1905. Serial. 1st part. No. 71007.

Cyaniding.

Cyanidation of Argentiferous Concentrate. Hugh G. Elwes. Gives tests aiming to show that by means of a preliminary chloridizing-roast rich silver ores, even when rebellious, can be successfully treated by cyanidation. 1800 w. Eng & Min Jour—July 2, 1905. No. 71015.

Cyaniding Silver-Gold Ores of the Palmarejo Mine, Chihuahua, Mexico. T. H. Oxnam. Describes the mines, the mill and cyanide plant, the old system of milling, and the experiments with wet-crushing, concentration and raw pan-amalgamation, the present system of milling and sands treatment, etc. Ills. 16500 w. Am Inst of Min Engrs—July, 1905. No. 71099 D.

Estimation of the Chief Constituents in Cyanide Solution. J. E. Clennell. Describes a method which has been in successful use in testing the solutions obtained in the treatment of gold-and silver-bearing ore at the Redjang Lebong mine, Sumatra. 2500 w. Eng & Min Jour—June 29, 1905. No. 70583.

The Development and Present Status of Cyanidation in the United States. William H. Davis. Reviews the history and methods, discussing crushing methods, alkalinity, treatment of coarse sands and slimes, and of high-grade ores, precipitation, regeneration, etc. 6000 w. Elec Chem & Met Ind—July, 1905. No. 70668 C.

Ore Treatment.

Ore Milling at Kalgoorlie. Harry J. Brooke. Describes the successful treatment of these ores, giving table showing the cost of one month's milling on 3,484 tons treated. 1500 w. Eng & Min Jour—July 6, 1905. No. 70671.

San Juan.

San Juan Region and Some of Its Peculiar Mines. Arthur Lakes. Describes this interesting region, and its peculiar features, and the American Nettie mine. Ills. 2000 w. Min Wld—July 15, 1905. No. 70766.

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Tonopah.

Tonopah Mining District. J. E. Spurr. An illustrated article giving an interesting description of this gold and silver mining district, and the geology of the region. Maps. 5000 w. Jour Fr Inst—July, 1905. No. 70841 D.

Utah.

The Newhouse Mine and Mill. Illustrated description of the properties in Beaver Co., Utah. 1000 w. Eng & Min Jour—July 15, 1905. No. 70754.

Yukon.

Mining in the Yukon. F. T. Congdon. Excerpt from a recent address sketching the evolution in mining methods since 1896. 3300 w. Can Min Rev—July, 1905. No. 71045 B.

IRON AND STEEL.

Blast Furnaces.

Experimental Studies of the Reactions in the Blast Furnace (Experimentelle Studien über die Vorgänge im Hochofen). Dr. F. Zimmermann. Describing studies in the analysis of gases drawn from various zones in the blast furnace, and conclusions therefrom. 2000 w. Stahl u Eisen—July 1, 1905. No. 70943 D.

Briquettes.

Iron Ore Briquettes for the Blast Furnace. Henry Louis. Reviews the history of ore briquetting, describing the operations, and stating the advantages, and explaining various methods. Ills. 4000 w. Cassier's Mag—July, 1905. No. 71030 B.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. Joseph W. Richards. A discussion of the paper by Mr. Gayley presented at the Lake Superior meeting. 3700 w. Am Inst of Min Engrs—July, 1905. No. 71095.

The Application of Dry-Air Blast to the Manufacture of Iron. T. W. Robinson. Discussion of paper by Mr. Gayley presented at the Lake Superior meeting and also at the New York meeting of the Iron and Steel Institute. 2500 w. Am Inst of Min Engrs—July, 1905. No. 91098.

Furnace Hoist.

Electrically-Driven Furnace Hoist (Elektrisch Betriebener Gichtaufzug). F. Collischonn. Illustrating and describing an inclined hoist, electrically driven, for automatically charging blast furnaces. 2000 w. Stahl u Eisen—June 15, 1905. No. 70940 D.

Gas Furnaces.

Progress in the Construction of Gas Furnaces for Use in Iron Works (Fortschritte im Bau von Gasöfen für Eisenhuttenwerke). A. Desgraz. A discussion of the application of gas-fired furnaces for reheating, and other metallurgical operations. Serial. Part I. 3000 w. Stahl u Eisen—July 1, 1905. No. 70942 D.

Grading.

Pig Iron Grading by Analysis. Hambden Buel. Abstract of a paper read before the Am. Soc. for Test Materials. Describes the method followed by the Central Iron & Coal Co., Holt, Ala. 1400 w. Ir Age—July 20, 1905. No. 70805.

Metallurgy.

Descriptive Metallurgy of Iron and Steel. Samuel Groves. The present number briefly reviews the progress of the stone age, bronze age, and iron age. Ills. 1400 w. Can Engr—July, 1905. Serial. 1st part. No. 70648.

Open Hearth.

Chemical Changes in the Open-Hearth Furnace. W. M. Carr. Gives diagrams showing the changes of composition occurring in a bath of molten metal treated under the open-hearth process when producing steel to enter into ordinary castings, with explanatory notes. 700 w. Ir & Steel Mag—July, 1905. No. 71087 D.

New Open-Hearth Steel Processes. P. Ackers. Read before the Min. & Met. Cong. at Liége. Considers the progress made by the open-hearth process, discussing recent improvements, especially the charging open-hearth furnaces with liquid pig-iron. 2200 w. Ir & Coal Trds Rev—July 11, 1905. No. 71000 A.

The Open-Hearth Process of Making Steel from Cast Iron (Die Herdofenstahlerzeugung aus Flüssigem Roheisen). Oskar Simmersbach. A review of the development of the open-hearth process, and its modifications and the extent to which it is superseding the Bessemer process. Two articles, 4000 w. Stahl u Eisen—June 15, July 1, 1905. No. 70939 each D.

Wrought-Iron.

The Manufacture and Characteristics of Wrought-Iron. James P. Roe. Briefly outlines the history of the manufacture of wrought iron, and discusses mechanical puddling, reactions of the puddled process, the structure of puddled iron, resistance to oxidation, defects of wrought-iron, and the conditions essential to successful puddling. 4500 w. Am Inst of Min Engrs—July, 1905. No. 71097.

MINING.

Bag-Houses.

Bag-Houses for Saving Fume. Reviews briefly the practice of filtration through cloth, and the applications, giving a description of a standard bag-house, and its operation. Ills. 1200 w. Eng & Min Jour—July 15, 1905. No. 70753.

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Results of Bag-House Experiment in Connection with Tavener's Process. H. Rusdett. Gives drawing showing the manner in which the bag-house was constructed, and experiments proving that practically no gold is carried over from the test furnace, anl very little from the pan furnace, if the charging is carefully done. 1200 w. Jour Chem, Met & Min Soc of S Africa—May, 1905. No. 70871 E.

Boreholes.

Electrical Devices for Deep Borehole Surveying. Hugh F. Marriott. Read before the Inst. of Min. & Met. Describes in detail the construction of two sets of instruments for use in deep level borehole surveying, and gives results obtained. 5000 w. Eng News—July 27, 1905. No. 71066.

Cables.

The Influence of Bending Torsion, and Shocks upon Wire Cables (Einige Beiträge zu Biegungs, Torsions und Stossversuchen mit Seildrähten). Julius Divis. Data and results of experiments upon a variety of wire ropes adapted for mine hoists. Three articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 17, 24, July 1, 1905. No. 70949 each D.

Compressed Air.

See Mechanical Engineering, Power and Transmission.

Concentration.

The Callow Settling Tank. W. S. Zehring. Illustrates and describes this tank for settling the dilute overflows found in every concentrating mill. 1500 w. Min Wld—July 15, 1905. No. 70767.

Dredging.

Dredging—I. Prospecting and Historical. J. P. Hutchins. Reviews the history of dredge mining as introductory to a discussion of present practice. 1500 w. Eng & Min Jour—July 15, 1905. Serial. 1st part. No. 70751.

Faults.

Faults with Special Reference to Coal and Metal Mining. A. Lakes. An illustrated article explaining where faults are most likely to occur, and the indications of their presence. 1400 w. Min Rept—July 6, 1905. Serial. 1st part. No. 70678.

Haulage.

Tests with Haulage System to Economize Air. Translation from an article in *Gluckauf*, by Fr. Hempel. Gives practical results from trial tests with an endless-rope haulage driven by duplex air cylinders. Ills. 1200 w. Mines & Min—July, 1905. No. 70689 C.

Hydraulic Mining.

Notes on Hydraulic Mining Practice. Richard L. Grider. Abstract of an article in the Colorado School of Mines "Bulletin," Jan., 1905. Illustrated description of methods of work in a hydraulic mine. 3500 w. Eng News—July 20, 1905. No. 70831.

Lead Smelting.

Lead Smelting in the Scotch Hearth. Kenneth W. M. Middleton. Describes the present method as practiced in the North of England. 2300 w. Eng & Min Jour—July 6, 1905. No. 70674.

Machine Drill.

The Machine Drill in Mining. Reviews the progress made with the machine drill, the work it has accomplished, and the methods. Also its importance in economical working. Ills. 3500 w. Min & Sci Pr—July 15, 1905. No. 71006.

Mexico.

The Minerals of Maguarichic. Rufus M. Baggs, jr. Points out some interesting crystallizations observed in specimens from this camp in Mexico. Ills. 1100 w. Eng & Min Jour—July 6, 1905. No. 70670.

Mine Signals.

Electric Mine Signals and Telephones. George E. Walsh. Brief review of what has been accomplished in Europe and America. 1200 w. Min & Sci Pr—July 8, 1905. No. 70778.

Mine Surveying.

Mine Surveying as Carried on at Centre Star Mine, Rossland, B. C. L. Heber Cole. Describes the methods employed by the engineering staff of the War Eagle and Centre Star Mining Companies. Ills. 4000 w. Can Min Rev—July, 1905. No. 71044 B.

Mining Investments.

See Industrial Economy.

Mining Plant.

The Electrification of Mexican Mines. George E. Walsh. Information concerning important electric plants recently established for mining purposes, usually combining transportation, lighting and mine operation. 1500 w. Eng & Min Jour—July 6, 1905. No. 70673.

The New Shaft Equipment and Washing Plant of the Bethune Mining Company (Bemerkungen über die Neueste Schachtanlage 10 und die Zentralwäsche der Bergwerksgesellschaft Bethune). Describing one of the latest coal mining plants in Northern France, with plate showing general arrangement. 2500 w. 1 plate. Glückauf—June 30, 1905. No. 70947 D.

The Plant at the Zollern Shaft No. II. of the Gelsenkirchen Mining Company (Die Schachtanlage Zollern II. der Gelsenkirchener Bergwerks-Aktien-Gesellschaft). H. Randebrock. A very fully

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illustrated description of a fine modern colliery equipment, including power house, head works, winding engines, etc. 7500 w. 3 plates. Glückauf—June 24, 1905. No. 70945 D.

Newfoundland.

Mineral Development in Newfoundland. Review of the annual report, compiled by James P. Howley, on the mineral statistics of the Island. 1800 w. Can Min Rev—June, 1905. No. 70657 B.

Norway.

Mining in Norway. M. Alger. Gives mines of various minerals with an account of their productions. 2500 w. the locations, histories, and products of Mines & Min—July, 1905. No. 70684 C.

Ore Deposits.

Ore Deposits of the Sierra De Los Caballos. Charles R. Keyes. Describes these deposits in South Central New Mexico. The ores found are galena carrying a small amount of silver, chalcopyrite and bornite, and gold bearing ores. Coal is also found, and lime and iron. 1800 w. Eng & Min Jour—July 29, 1905. No. 71110.

Organic Remains in Ore Deposits. Arthur Lakes. Interesting descriptions of animal and vegetable remains found in various mines. 2000 w. Eng & Min Jour—June 29, 1905. No. 70582.

Prospecting.

Prospecting with Churn Drills. George C. McFarlane. Illustrates and describes two arrangements devised by the writer which have worked successfully, describing methods used. 1800 w. Eng & Min Jour—July 29, 1905. No. 71108.

Pyrite.

Pyrite Mining in Virginia. R. H. Painter. Describes deposits of pyrite carrying more or less copper, the methods of mining, preparation for market, etc. 1700 w. Eng & Min Jour—July 29, 1905. No. 71109.

Pyritic Smelting. Abstract of the presidential address of Robert C. Sticht, before the Aust. Inst. of Min. Engrs. Gives an outline of its history. 2500 w. Aust Min Stand—June 7, 1905. Serial, 1st part. No. 70702 B.

Respirator.

The Pneumatogen, a New System of Respiration (Pneumatogen, ein Neues System von Atmungsapparaten). Drs. M. Bamberger and F. Böck. Describing an apparatus for exploring gaseous mines, employing sodium peroxide for regenerating the air. 4500 w. Glückauf—June 24, 1905. No. 70946 D.

Roasting.

Temperature in Roasting Gold Ore. William E. Greenawalt. Suggestions helpful in getting the best results, reporting laboratory experiments. 1200 w. Eng & Min Jour—July 29, 1905. No. 71107.

Safety Catches.

Safety Catches for Mine Cages. E. Mackay Heriot. Points out the risks from the cable breaking while hoisting, and illustrates some of the methods adopted for safety. 2000 w. Eng & Min Jour—July 22, 1905. No. 71014.

Screens.

Standard Screens for Screen Analysis. Courtenay de Kalb. Describes a set of screens based upon an arithmetical progression of successive differences between the differences in diameters of openings in successive screens. 1000 w. Eng & Min Jour—July 29, 1905. No. 71111.

Shafts.

A Device for Preventing Freezing in Drawing Pits. Dr. Alfred Gradenwitz. Illustrated description of the use of warm air to prevent the formation of ice in mine shafts. 500 w. Min Rept—July 6, 1905. No. 70677.

Concrete Lining for Mine Shafts. F. R. Dravo. Briefly considers other materials that have been tried, and describes the work of lining a shaft with concrete. General discussion. 3300 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71104 D.

Sketches.

The Use of Sketches in the Mining Field. Arthur Lakes. Shows the advantages of sketching illustrations to accompany a mining report. Ills. 1200 w. Min Wld—July 22, 1905. No. 71003.

South Africa.

South African Mining. Fred E. Norton. On the extent to which compressed air is used, describing the peculiar conditions and the type of compressors. 3200 w. Mines & Min—July, 1905. No. 70683 C.

Structure.

Origin of Orbicular and Concretionary Structure. William P. Blake. Gives views of various writers in regard to the origin, and the results of a study of the white volcanic Tufta of Tucson, Ariz. Ills. 1500 w. Am Inst of Min Engrs—July, 1905. No. 71093.

Tube Mill.

The Theory of the Tube Mill. H. A. White. Illustrates and describes models and discusses the best rate of driving tube mills. 6000 w. Jour Chem, Met & Min Soc of S. Africa—May, 1905. No. 70872 E.

Valuation.

On the Examination and Valuation of Mines. John E. Hardman. Read before the Canadian Soc. of Civ. Engrs. An account of approved practice, with special reference to the difficulties or advantages, which Canadian deposits present. 4800 w

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Can Min Rev—June, 1905. Serial. 1st part. No. 70659 B.

Veins.

The Occurrence of Pebbles, Concretions and Conglomerate in Metalliferous Veins. Edward Halse. Discusses the four causes to which these occurrences are attributed. 6000 w. Ills. Am Inst of Min Engrs—July, 1905. No. 71096 C.

Vein Outcrops. Gives sketches of a number of characteristic outcrops, with a diversity of geological conditions. 1400 w. Min Sci Pr—July 22, 1905. No. 71049.

Ventilation.

Outlines of Mine Ventilation. William Clifford. Discusses the art of producing a safe atmosphere in the underground workings of a coal mine, describing the earliest practice and tracing the progress. Ills. 3500 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71102 D.

Winding.

Electric Winding Machines. Prof. Paul Habets. Read before the Inst. of Mech. Engrs. Gives a dynamic investigation of electric winding for collieries. 6500 w. Engng—June 30, 1905. Serial. 1st part. No. 70726 A.

The Steam Consumption of a Winding Engine (Versuche uber den Dampf verbrauch einer Dampfördermaschine). A. Czermak. With indicator and load diagrams showing the irregular work, and the economy effected by the use of cut-off. 2500 w. Oesterr Zeitschr f Berg u Huttenwesen—June 24, 1905. No. 70950 D.

MISCELLANY.

Aluminothermics.

Aluminothermics. E. Stuetz. Summary of a lecture before the Civ. Engrs. Club of Cleveland. Describes a few instances of the use of burning aluminum for the production of high temperatures. Ills. 1000 w. Jour Assn of Engng Socs—May, 1905. No. 71090 C.

The Use of Thermit in a Railroad Shop. Jas. F. Webb. Read before the Am. Found. Assn. Gives the writer's experience in making repairs with thermit. Ills. 1200 w. Foundry—July, 1905. No. 70860.

Asbestos.

Arizona Asbestos Deposits. Joseph Hyde Pratt. Describes the location and development of these deposits, the occurrence, etc. 1300 w. Min Wld—July 8, 1905. No. 70662.

Canada.

"Rare Minerals" in Canada. A report of the movement with a view to search for and mine the rarer minerals, such as radium, white mica, tourmaline, garnet, beryl, and others. 1200 w. Can Min Rev—June, 1905. No. 70658 B.

Exposition.

The Liége Exposition (Lütticher Weltausstellung). A review of the Liége industrial exposition with especial reference to the mining and metallurgical exhibits. Serial, Part I. 1500 w. Stahl u Eisen—June 1, 1905. No. 70938 D.

Graphite.

The Graphite Industry. Joseph Hyde Pratt. States the many uses of graphite, its occurrence, deposits, localities developed, etc. 3500 w. Min Wld—July 22, 1905. No. 71004.

Metallurgy

Metallurgy at the Meeting of the German Bunsen Society. Brief reviews of papers and discussions dealing with the physical properties of metals and alloys, presented at the Karlsruhe meeting, June 2d and 3d, 1905. 2400 w. Engr, Lond—July 14, 1905. No. 70890 A.

Natural Gas.

Natural Gas Pumping Plant at Hundred, West Virginia. F. C. Weber. Illustrates and describes a plant by which gas from wells is transmitted a distance of ninety miles. 3200 w. Mines & Min—July, 1905. No. 70681 C.

Radium.

Pitchblende and Carnotite. Dr. J. Ohly. Information concerning the concentrates produced by these radio-active minerals, and the methods of treatment 900 w. Min Rept—June 29, 1905. No. 70564.

Salt.

The Salt Deposits of Northeastern Ohio. J. A. Bownocker. An account of the discovery and report of the wells. Plate. 1500 w. Am Geol—June, 1905. No. 70797 D.

Sardinia.

The Lead and Zinc Mines of Monteponi. Charles Will Wright. An interesting illustrated description of these mines in Sardinia, their location, development, methods of mning, etc. 1800 w. Min Mag—July, 1905. No. 70859 C.

Soft-Lead.

Soft Lead Resources of the United States. H. Foster Bain. Map, showing the more important of the lead-producing districts, with information concerning the deposits. Ills. 2400 w. Min Mag—July 1, 1905. No. 70857 C.

Technical Chemistry.

Some American Contributions to Technical Chemistry. Marcus Benjamin. An address delivered before the Congress of Arts and Sciences, St. Louis. A review of the discoveries of American chemists, including many advances in metallurgy. 5700 w. Sci Am Sup—July 29, 1905. No. 71085.

We supply copies of these articles. See page 991.

Tin.

Tin Mining and Smelting at Santa Barbara, Guanajuato, Mexico. A. H. Bromly. Describes the unusual character of these deposits, the workings, etc., giving results. Ills. 2200 w. Am Inst of Min Engrs—July, 1905. No. 71092.

Tin Plate.

The Making of Tin Plate. Illustrates and describes the modern process of manufacture. 2500 w. Met Work—July 29, 1905. No. 71078.

Tungsten.

The Boulder County, Colorado, Tungsten Deposits. Kirby Thomas. Remarks on the demand for tungsten due to its use as an alloy for high-grade steels, and an account of these deposits. Map. 1400 w. Min Wld—July 8, 1905. No. 70660.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Recording.

A New Method of Car Recording. F. Lincoln Hutchins. Brief description of a method using a registering machine. 900 w. Ry Age—July 28, 1905. No. 71106.

Explosives.

Transportation of Explosives on the P. R. R. Extracts from a recent circular giving regulations for the transportation of the various classes of explosives. 900 w. R R Gaz—Vol. XXXIX. No. 2. No. 70772.

Fast Trains.

Fastest Trains in the World. Angus Sinclair. Remarks on the 18-hour trains between New York and Chicago, run by the New York Central and the Pennsylvania lines, with illustrations of engines and cars. 1000 w. Ry & Loc Engng—July, 1905. No. 70666 C.

The New York-Chicago Fast Trains. A record of the speed of the special trains run over the road in June, with remarks. 1300 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70555.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Intermediate Valves as Applied to Straight Line Brake Systems. H. G. Westbrook. Explains the functions this valve must perform, and gives an illustrated description of a new design. 900 w. Compressed Air—June, 1905. No. 70795.

Caboose.

Four-Wheeled Caboose for the Big Four. Description, with engravings showing their construction and arrangement. 1000 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70558.

Cars.

The Hart Convertible Ballasting and Freight Car, and the Work of Ballasting Track. Illustrates and describes this convertible dump car and its operation. 2200 w. Eng News—July 6, 1905. No. 70615.

Electrification.

Lancashire and Yorkshire Railway—Bullfield Widening: Bolton. Illustrated description of the improvements recently effected, especially the application of electricity. 2200 w. Elec Engr, Lond—July 14, 1905. No. 70881 A.

Exhibition.

Locomotives at the Liége Exhibition. C. R. King. Describes interesting locomotives being shown at this important exhibition. 3300 w. Ry Age—July 14, 1905. No. 70763.

The Liége Exhibition. The present article describes the locomotives shown. Ills. 3000 w. Engr, Lond—June 23, 1905. Serial. 1st part. No. 70642 A.

Locomotives.

A French Locomotive with Water-Tube Boiler. Information and sections of a locomotive put in service on the Algerian lines of the Paris, Lyons and Mediterranean Railway. 700 w. Mech Engr—July 1, 1905. No. 70708 A.

A Unique Locomotive for South Africa. F. C. Coleman. Illustration, with brief description of an unusual design for working heavy freight trains over the severe grades and sharp curves on the Rhodesia railway. 800 w. Sci Am—July 29, 1905. No. 71081.

Central Vermont Compound Consolidation. Illustrated detailed description of Compounds constructed on the Richmond system. 350 w. Ry Age—June 30, 1905. No. 70566.

Compound Articulated Locomotive for South America. Gives the first of a series of drawings of compound locomotives on the articulated system, built for the metre-gauge line of the Central Northern Railway of the Argentine Republic,

We supply copies of these articles. See page 991.

with brief note. 150 w. Engng—July 14, 1905. Serial. 1st part. No. 70897 A.

Eight-Wheel Passenger Engine with Superheater, D. L. & W. R. R. Illustrations and descriptive data of an anthracite culm burner. 800 w. Ry Mas Mech—July, 1905. No. 70845.

Extended Piston Rods on Union Pacific Vauclain Compounds. G. H. Likert. States the difficulties experienced with the first design, and the remedy by the use of extended piston rods. 900 w. R R Gaz—Vol. XXXIX. No. 4. No. 71077.

Four-Cylinder Balanced Compound Passenger Locomotive, Pacific Type. Illustrated description of an important design for the Oregon R. R. & Nav. Co., in which the Vauclain 4-cylinder compound arrangement was applied to a six-coupled engine. 500 w. Am Engr & R R Jour—July, 1905. No. 70587 C.

Four-Cylinder Compound Locomotives on the Paris-Orleans Railway. Abstract of an article by M. P. Gone in *La Revue Générale*. Description, with results of tests, dynamometer records, etc. 1500 w. R R Gaz—Vol. XXXIX. No. 4. No. 71076.

Pacific Type Four-Cylinder Balanced Compound Locomotive. Illustrated description of an engine built for the Oregon Railroad & Navigation Co. 300 w. Ry Age —July 14, 1905. No. 70764.

Paris Ceinture Railway. Tandem Compound Locomotive. Illustrates and describes a type in use in France, with report of performance on suburban rapid service. 1200 w. Engr, Lond—July 7, 1905. No. 70793 A.

Powerful Switching Locomotives for the Lake Shore. Illustrated description of the largest and most powerful switching engines yet built, intended for pushing trains over the humps in gravity yards. 300 w. R R Gaz—Vol. XXXIX. No. 3. No. 70850.

Service of the Mallet Compound on the Baltimore and Ohio. Gives the average performance of this locomotive for 24 consecutive trips helping trains over the mountain districts, with information. 1000 w. Ry Age—July 7, 1905. No. 70650.

Six-Wheel (0-6-0) Switching Engine, Southern Railway. Brief illustrated description. 200 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70557.

The Development of Large Locomotives. Arthur M. Greene, Jr. An illustrated review of the development and growth of the large locomotive. 3500 w. Pro St Louis Ry Club—June 9, 1905. No. 70814.

Oscillations.

The Behavior of Locomotive Suspensions (Le Fonctionnement des Organes de la Suspension dans les Locomotives). A. Herdner. An examination of the influence of the method of suspension of a locomotive upon the magnitude and extent of its oscillations. Serial. Part I. 7500 w. Rev Gen des Chem de Fer—June, 1905. No. 71053 G.

Refrigerator Cars.

Development of Refrigerator Car Service on the Burlington. Reviews the history of their use and gives facts of interest in regard to the service, especially on the road named. 2500 w. Ry Age—June 30, 1905. No. 70565.

Staybolts.

Locomotive Water Space Stays. B. E. D. Stafford. A comparison of flexible and rigid stay bolts, illustrating types. Discussion. 6500 w. Pro Ry Club of Pittsburgh—April, 1905. No. 70813 C.

Superheaters.

Superheaters in Locomotives. J. B. Flamme. Read before the Inst. of Mech. Engrs. at Liége. Illustrated description of the arrangements for producing superheated steam in some engines on the Belgium State Railways and report of results. 2800 w. Engng—June 23, 1905. No. 70638 A.

Tender.

7,000-Gal. Tender of the Louisville & Nashville. Drawings of underframe, plan and sections of tank are given, with brief description. 600 w. R R Gaz—Vol. XXXIX. No. 2. No. 70769.

NEW PROJECTS.

Extension.

Extending the Santa Fe Railroad into San Francisco. Herbert I. Bennett. Illustrates and describes an interesting piece of railroad construction in California, where a swamp was crossed on an embankment of peat and decayed tule grass. 1200 w. Sci Am Sup—July 15, 1905. No. 70747.

South Africa.

The Central South African Railways. A review of the work accomplished and projected. 1500 w. Engr, Lond—July 7, 1905. No. 70792 A.

PERMANENT WAY AND BUILDINGS.

Locomotive Works.

A Large Locomotive Building and Repair Works in France. Charles R. King. A fully illustrated account of the shops of the Eastern Railway of France at Epernay. 4500 w. Engineering Magazine—August, 1905. No. 71055 B.

We supply copies of these articles. See page 991.

Maintenance.

Some Records of Maintenance-of-Way Expenses on American Railways. Replies to inquiries and information from individual railway companies, with editorial discussion. 6000 w. Eng News—July 27, 1905. No. 71063.

Rail Sections.

The New British Standard Rail Sections. Gives the principal parts of the specifications, with comments. 1500 w. Eng News—July 27, 1905. No. 71062.

Rails.

Some Causes of Failure of Rails in Service. Robert Job. From a paper read before the Am. Soc. for Testing Materials. Gives the causes brought out by extensive investigations of rail failures made by the Philadelphia & Reading Railway. Ills. 1800 w. R R Gaz—Vol. XXXIX. No. 1. No. 70675.

Signals.

A New System of Signalling on the Midland Railway. Illustrates and describes the new system of electric signalling installed at Derby station. 3800 w. Elect'n, Lond—June 23, 1905. No. 70635 A.

The Krupski System of Electric Distance Signals (Krupskis Stromlauf an ordnung für Elektrische Distanz signale). L. Kohlfürst. A detailed description of the automatic electric signal system used on the Swiss railways. 1800 w. Schweiz Bauzeitung. June 3, 1905. No. 70953 B.

Switzerland.

The Prolongation of the Appenzell Railway from Gais to Appenzell (Die Verlängerung der Appenzeller Strassenbahn von Gais nach Appenzell). L. Kürsteiner. With profile and topographical map of the route and details of the combined adhesion and rack locomotives. 1800 w. Schweiz Bauzeitung—June 17, 1905. No. 70955 B.

Terminals.

Recent Terminal Improvements in St. Louis. Daniel Breck. Gives a general view of the problems as they presented themselves and the methods employed in defining difficulties and reaching solutions. 9 plates. 5500 w. Jour Assn of Engng Socs—May, 1905. No. 71088 C.

Some Details of Reconstruction Work, St. Louis Union Station. A P. Greensfelder. Describes the work at the St. Louis station and vicinity which was under the direct charge of the writer, giving reasons for the adoption of the various plans and methods. 10,000 w. Jour Assn of Engng Socs—May, 1905. No. 71089 C.

The Baltimore Terminal of the Western Maryland R. R. Illustrated description of the Atlantic terminus of the Gould railroad system. 2500 w. Eng Rec—July 1, 1905. No. 70598.

Ties.

Creosoting Works of the Western Railway of France. Extracts from an article by J. M. Merklen, in *Revue Generale des Chemins de Fer*, giving particulars of the plant at Surdon, France. 1200 w. Eng News—July 27, 1905. No. 71064.

TRAFFIC.

Clearing System.

Further Observations Regarding the Railway Clearing House of England. J. W. Midgley. Considers the difficulties due to freight classification, and discusses the "coaching" department in England, the mileage department, and other English methods. 5000 w. Ry Age—July 7, 1905. Serial. 1st part. No. 70651.

Industrial Departments.

Industrial Departments of Railways. Discusses methods of modern management to provide for future traffic and increase the revenue. 2500 w. Ry Age—July 14, 1905. No. 70765.

Interline Accounts.

Method of Settling Interline Accounts. A paper prepared under instructions from the Assn. of Am. Ry Acc. Officers, explaining the manner of settling interline accounts between railroads in the United States, Canada and Mexico. 1500 w. Ry Age—July 14, 1905. No. 70762.

Rates.

English Railway Rate Making and Governmental Rate Control. Abstracts from a recent work by W. M. Acworth, with comments by W. D. Taylor. 4500 w. Ry Age—July 21, 1905. No. 71009.

MISCELLANY.

Estimates.

Estimates for Railways for Light Traffic. William D. Marks. Gives detailed estimates of such railways, discussing a recent paper by Jas. Cravath. 2200 w. Eng News—July 20, 1905. No. 70829.

France.

Financial Results of the French Railroads in 1903. Statement of the results of operation, with comparison with 1902, and review of the accounts in general. 2400 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70556.

Legislation.

Connecticut's New Railroad Legislation. Clarence Deming. A review of what was accomplished in the legislative session of 1905, especially as affecting the New Haven Company. 2000 w. R R Gaz—Vol. XXXIX. No. 3. No. 70851.

We supply copies of these articles. See page 991.

STREET AND ELECTRIC RAILWAYS

Car Designs.

Car Designs and Carrying Capacity. John P. Fox. A second article, discussing doors, vestibules, etc. Illustrated. 2700 w. St Ry Jour—July 1, 1905. No. 70575 C.

Cars.

Suitable Cars for City and Suburban Service. T. W. Wilson, Read before the St. Ry. Assn. of the State of N. Y. Discusses the size and arrangement of cars for interurban and for city service. 2200 w. St Ry Jour—July 8, 1905. No. 70656 C.

Types of Interurban Cars. J. N. Shannahan. Read before the St. Ry. Assn. of the State of N. Y. Describes two types of cars used on the Fonda, Johnstown & Gloversville R. R., pointing out the advantages and disadvantages of the service. 1500 w. St Ry Jour—July 1, 1905. No. 70579 C.

Germany.

Electric Traction Systems of the Future (Die Elektrischen Bahnsysteme der Gegenwart). F. Niethammer. A general examination of the various systems in use and proposed for tramway and railway service. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70911 D.

The Proposed Blankenese-Ohlsdorf Electric Railway (Ueber den Geplanten Elektrischen Betrieb der Hamburger Stadtbahn Blankenese-Ohlsdorf). Gustav Schimpff. With map and profiles of the extension of the Hamburg electric railway system to neighboring towns using single phase traction. 3500 w. Elektrotech Zeitschr—June 22, 1905. No. 70976 B.

The Future Development of Electric Railways in Germany (Die Zukünftige Entwickelung der Elektrischen Bahnen in Deutschland). Dr. R. Haas. A. Review of electric traction in Germany, and its influence upon main-line projects. 5000 w. Elektrotech Zeitschr—June 29, 1905. No. 70978 B.

Interurban.

Permanent Way and Structures of the Toledo Urban and Interurban Railway. John S. Worley. Describes the construction of this road as an example of high grade work. Ills. 2800 w. Eng News—July 13, 1905. No. 70743.

The San Jose and Los Gatos Interurban Railway Company. Illustrates and describes this system, which is distinctively a passenger road, though considerable freight is hauled. 2500 w. Jour of Elec—July, 1905. No. 71037 C.

Instruction Car.

New Instruction Car for the Brooklyn Rapid Transit Company. Illustrated detailed description of the car and its equipment. 2400 w. St Ry Jour—July 29, 1905. No. 71050 C.

Manila.

Electric Railroad and Light System of Manila. An illustrated article giving information of the stations, and their equipment, power house, etc. 4500 w. Far East Rev—May, 1905. No. 70803 D.

Motor Connections.

Mistakes in Motor Connections and Their Effects. Cale Gough. Gives a diagram showing all the misconnections possible of the No. 1 motor leads, with the effects produced, with explanatory notes. 1000 w. St Ry Jour—July 8, 1905. No. 70654 C.

Mountain Railway.

A French Mountain Railway. Brief illustrated description of the electric mountain railway operating between Chamonix and Fayet, in the Mont Blanc region. 700 w. Ry Age—July 21, 1905. No. 71010.

New Electric Cars for Adhesion and Rack Driving on the Stansstad-Engelberg Railway (Neuer Elektrischer Automobilwagen für Adhäsions und Zahnstangen betrieb der Stansstad Engelbergbahn). W. Burkard. With diagrams and photographs of the trucks, showing arrangement of motors and gearing. 2500 w. Schweiz Bauzeitung—May 20, 1905. No. 70951 B.

Portable Sub-Station.

Portable Sub-Station for Cincinnati & Columbus Traction Company. John R. Hewett. Illustrated description of this car and the apparatus installed. 1500 w. St Ry Jour—July 8, 1905. No. 70653 C.

Power Station.

A Large Power Station Operated with Fuel Oil. W. D. Chamberlain. Illustrated detailed description of the North Beach power station of the United Railroads of San Francisco, and its equipment and operation. 6800 w. Power—Aug., 1905. No. 71033 C.

Brunots Island Power Station of the Pittsburg Railways Co. Illustrated detailed description of the station and its equipment. 1600 w. St Ry Rev—July 15, 1905. No. 70855 C.

We supply copies of these articles. See page 991.

New Power Station of the Saginaw and Bay City Railway and Light Company. Illustrated detailed description. 3300 w. Engr, U S A—July 15, 1905. No. 70757 C.

Power House for the New York Central Electric Lines. An illustrated description of the generating station under construction at Utica, N. Y., from which power will be distributed east and west along the lines of electric railway that parallel the New York Central R. R. 1800 w. Elec Wld & Engr—July 15, 1905. No. 70758.

See also Electrical Engineering, Generating Stations.

Rapid Transit.

Rapid Transit in Great Cities. William Barclay Parsons. From an address delivered at Purdue University. An interesting article dealing mainly with underground railways, their engineering and legal aspects, and various phases of the problem. 6000 w. R R Gaz—Vol. XXXIX. No. 3. No. 70849.

Regulator.

Single-Phase Induction Regulator. B. G. Bergman. Describes the design and explains the operation. The field for the induction regulator is apparently limited to heavy locomotives for freight service. 2000 w. Elec Wld & Engr—July 8, 1905. No. 70691.

Road Traction.

Trackless Electric Traction (Gleislose Elektrische Bahnen). Max Schiemann. A review of the recent progress in the use of the overhead electric trolley system for use on common roads. 3000 w. Elektrotech Zeitschr—July 6, 1905. No. 70981 B.

Scotland.

The Paisley and District Tramway System. An illustrated account of this undertaking, with map. 3500 w. Tram & Ry Wld—July 13, 1905. No. 70846 B.

Shops.

New Car Shops and Houses for the Public Service Corporation of New Jersey. Martin Schreiber. Gives plans and description of one of the most complete and modern railways shop and car-house plants in the country, soon to be erected at Newark, N. J. 6500 w. St Ry Jour—July 22, 1905. No. 71012 C.

Single Phase.

The Single-Phase Railway System, Its Field and Its Development. Charles F. Scott. Reviews briefly the status of electric railway engineering just prior to the announcement of the single-phase railway motor, and the engineering evolution of the system since that time. 2200 w. Elec Jour—July, 1905. No. 70808.

Single-Phase.

The Development of the Single-Phase Railway System. Gives a table of lines using or proposing to use the Westinghouse system of single-phase railway traction, and describes the apparatus employed and the general manner of operating the Indianapolis and Cincinnati Railway. Ills. 2000 w. Engng—July 28, 1905. No. 71251 A.

Sub-Station.

The Fisher Street Street Sub-Station of the Metropolitan Electric Supply Co., Ltd. Illustrated detailed description, especially of switch gear. 2400 w. Elec Rev, Lond—July 28, 1905. No. 71250 A.

Swansea.

Swansea Electricity Undertaking and Tramway Department. C. A. L. Prusmann. Briefly describes the pump-room, boiler-house, economizer shed, engine-room, battery-room, feeders and distributing mains, equipment, &c. Ills. 3000 w. Elec Engr, Lond—July 28, 1905. No. 71249 A.

Sunderland.

Sunderland District Tramways. Illustrated description of a system serving a moderately populated district. 2200 w. Tram & Ry Wld—July 13, 1905. No. 70847 B.

Terminal.

The New Manhattan Terminal for the Brooklyn Bridge. Illustrations and description of the principal features of the proposed new station, and the arrangement of tracks. 600 w. R R Gaz—Vol. XXXIX. No. 2. No. 70771.

Traction Work.

The Electrical Engineer in Heavy Traction Work. William McClellan. A discussion of the special problems and methods developed in this line of work. Ills. 11400 w. Pro Engrs' Club of Phila—July, 1905. No. 70867 D.

Trolleys.

Trolley Standards: Their Liability to Become Dangerous to the Public, and Some Devices for Rendering Them Safe. P. J. Pringle. Refers especially to dangers on double-deck cars, giving an illustrated description of a device for promoting safety. 2200 w. Elec Engr, Lond—July 14, 1905. No. 70882 A.

Variable Load.

The Relation of Variable Load to Cost of Transmission in Electric Railway Problems. Sydney W. Ashe. Shows how the line loss may be found from the load diagram, giving examples. 600 w. Eng News—July 13, 1905. No. 70741.

Wheels.

The Wheel Question. C. G. Bacon, Jr. Gives results of recent investigations of wheels and conclusions drawn, discussing certain points. 2000 w. St Ry Jour—July 8, 1905. No. 70655 C.

We supply copies of these articles. See page 991.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berl'n.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

NEWS SUPPLEMENT

Personal.

—J. W. Duntley, president of the Chicago Pneumatic Tool Co., sailed recently for a five weeks trip to Europe, in the interests of the pneumatic tool business.

—L. D. Bolton, formerly Chicago representative of the Federal Manufacturing Co., is now with the Diamond Chain & Manufacturing Co., Indianapolis, and will represent that company in the middle and western states.

—F. H. Jones, formerly manager of the air compressor department of the International Steam Pump Co., has been appointed general sales manager, and will take up the organization of a comprehensive general sales department.

—W. G. Schron, who has been in the employ of the Westinghouse Machine Co. as a salesman, recently entered the service of the Allis-Chalmers Co., Milwaukee. He will make his headquarters at their Pittsburg office and devote his attention to the sale of gas engines, steam engines and steam turbines.

Industrial Notes.

—Riter-Conley Manufacturing Co., Pittsburg, has removed the New York office to the Trinity Building.

—Parson Manufacturing Co. announces its removal to larger offices in the Barclay Building, 229 Broadway, New York.

—Ashton Valve Co., Boston, has removed the New York office to 128 Liberty St., where they will carry a stock of pop safety valves, gages, etc.

—American Steam Gauge & Valve Co., Boston, exhibited a full line of gauges, valves, indicators, etc., at Washington during the International Railway Congress.

—Power Specialty Co., New York, advise that their Chicago office will move from the Monadnock Block to The Rookery. Alex. Bradley, the Chicago sales manager, will remain in charge.

—Reeves Engine Co., New York, announce that owing to their rapidly increasing business it has been necessary to take more commodious offices and that they will occupy a suite on the seventh floor of the building in which they are now located.

—The Stirling Co. announces the removal of its executive and accounting departments from the Pullman Building, Chicago, to the Trinity Building, New York. They will, however, continue to maintain their present offices in Chicago.

—Pittsburg Gage & Supply Co., Pittsburg, has recently been awarded a contract for a complete White Star continuous oiling system to be used in connection with 32,000 horse power of engines in the plant of the Lackawanna Steel Co., Buffalo.

—Diamond Drill & Machine Co., Birdsboro, Pa., has changed its name to the Birdsboro Steel Foundry & Machine Co. The change is merely one in name, and they will continue to manufacture the same products, including the Diamond drills. They will also continue to take contracts for prospecting.

—The Abner Doble Co., San Francisco, announce that arrangements have been made with the John McDougall Caledonian Iron Works Co., Ltd., Montreal, whereby the latter become sole licensees for the manufacture of the Doble system of water wheels in the Dominion of Canada. They already have in hand the building of a 100 horse power wheel to operate under 170 feet head taking water through a 3½ inch jet and having a speed of 130 revolutions per minute.

—A. S. Cameron Steam Pump Works, New York, has withdrawn the agency from the Mine & Smelter Co., and in the future will be represented by Cary & Fielding, 1711 Tremont St., Denver; Utah Mining, Machinery & Supply Co., 228 South, West Temple St., Salt Lake, Utah; Ingersoll-Sergeant Drill Co., El Paso, Texas; Victor M. Braschi & Co., Cadenas St. 2, Mexico City, Mexico. These firms will carry a full line of the Cameron pumps and repair parts in stock.

—The Robb-Mumford Boiler Co., Inc., announces that it has acquired the plant and good-will of Edward Kendall & Sons, and that it will continue the manufacture of

fire tube boilers, tanks and sheet iron work of all description, making a specialty of internally-fired boilers. While no change will be made immediately in the location of the business, the company will during the present year occupy buildings now being erected at South Framingham, Mass., which will be equipped with all modern appliances for the manufacture of boilers and sheet iron work.

—While it is often commented that many notably successful manufacturing plants owe a large measure of their success to a scientific utilization of waste or by-products, many a house, otherwise carefully managed, continues to make no use of factory waste, says William M. Booth, chemical engineer, Syracuse, N. Y. Mr. Booth has made a special study of the utilization of factory waste, and has in many instances turned into an asset waste products which have long been discarded. This field of inquiry opens many interesting possibilities, and must become more and more important with the increasing tendency to conduct all manufacturing on more scientific and economical lines.

—The Lawrence Pump & Engine Co., Lawrence, Mass., has just shipped ten of their improved "Vortex" centrifugal pumps to the Kimberly & Clark Co., Kimberly, Wis. Four of these pumps are directly connected to electric motors, the larger one having a capacity of 3,000,000 gallons per day and to be operated by a motor of 75 horse power. They also report having closed a contract for all of the centrifugal pumps to be used in the new mill of the Bryant Paper Co., Kalamazoo, Mich. Other shipments include a 6 inch pump and engine to the Allentown Rolling Mills, Allentown, Pa., a 12 inch high pressure "Vortex" centrifugal pump to the International Paper Co., Corinth, N. Y., a 5 inch bronze fitted pump to the Standard Oil Co., Jersey City.

—The Albany (N. Y.) Steam Trap Company have recently had drawn to their attention an instance of the long life and economy of their trap. A trap was installed in the New York Central roundhouse at Poughkeepsie in 1878. It gave uninterrupted satisfaction until about 1903, when some of the parts began to show wear, but the defect was not thought great enough to require immediate attention until February of the present year. At that time new fittings were provided, and the foreman of the shops, E. Van Keuren, checked up for twenty-five days the coal and water used, as against the same number of days in January. He found a saving of about 125,000 gallons of water, and more than sixty-six tons of coal in an average monthly consumption of 296 tons. The trap in question returns the water of condensation from the heating system of the repair shop, roundhouse and passenger station and dining room, and back to the boiler. The steam and condensed water travel through a circuit of 885 feet of piping.

—The Westinghouse Companies, Pittsburg, have closed the following contracts: The Wisconsin Light and Power Co., La Crosse, Wis., two alternating current generators with an output of 400 kilowatts each, which will be driven by Westinghouse-Parsons steam turbines; there are three Westinghouse vertical steam engines, one of which will be connected to a 25 kilowatt direct current generator. The order also includes two motor generator sets, each consisting of a 7½ kilowatt direct current generator and a 15 horse power type C induction motor; three 10 kilowatt and three 15 kilowatt O. D. transformers; one 6600 volt ten panel switchboard and one 220 volt arc lamp panel; fifteen low equivalent lightning arresters and choke coils; 25,000 incandescent lamps with Edison base. Roney stokers, manufactured by The Westinghouse Machine Co. will be used in the boiler installation. The Morgan Engineering Co., Alliance, O. —eight railway type crane motors with a total of 250 horse power; The Pond Machine Tool Co., Plainfield, N. J.—twenty-eight type C induction motors; Niles Tool Works, Cincinnati, O.—five type S direct current motors; Long & Allstatter Co., Hamilton, O.—thirteen type S motors; the Delaware, Lackawanna and Western Ry.—twenty type CC induction motors; U. S. Hoe and Tool Co., Columbus—eight type SS motors; the Austin Power Co.—ten type C induction motors.

—Allis-Chalmers Co., Milwaukee, report recent installations of their machinery as follows: The Cleveland Electric Railway Co., Cleveland, one heavy duty cross compound Reynolds-Corliss condensing en-

gine, having cylinders 32 and 68 inches in diameter and a 60 inch stroke. This will be direct connected to a 1500 horse power street railway generator; San Joaquin Power Co., Fresno, Cal., two 1000-kilowatt Bullock water wheel type alternating current generators, seven 350-kilowatt and four 500-kilowatt transformers, with exciters and other apparatus. The generators will produce a 3 phase, 60 cycle alternating current. A voltage of 33,000 will be used over the 76 miles of transmission; United States Coal and Coke Co., Pittsburg, one heavy duty cross compound non-condensing Reynolds-Corliss engine, having cylinders 24 and 42 inches in diameter and a 42 inch stroke. It will be direct connected to a 750-kilowatt alternating current generator; Shenango Furnace Co., for its plant at Sharpsville, Pa., one vertical "Standard" type furnace blow engine, with cylinders 44 and 84 inches in diameter and a 60 inch stroke; Branch Mint Gold Mining Co., Galena, S. D., one No. 6 Gates rock breaker for the 120 stamp mill; Tuolumne Electric Co., San José, Cal., one 600-kilowatt alternating current generator, two 35-kilowatt generators and three 200-kilowatt transformers to be installed on the Tuolumne River; Herzog Art Furniture Co., Cleveland, one 100-kilowatt 3-phase, 60 cycle, alternating current generator. With it will be installed an exciter, switch-board and several motors, ranging in size from 5 horse power and 20 horse power; Cincinnati, Milford and Loveland Traction Co., five complete car equipments, each consisting of four 50 horse power, 500-volt Bullock motors, for double and control street cars, together with other auxiliary apparatus; Hamilton Gas and Electric Co., Cincinnati, two 250-kilowatt Bullock engine type alternators, two 15-kilowatt type B exciters, and one 150 horse power induction motor, direct coupled to a 100-kilowatt D C generator; H. C. Frick Coke Co., to be installed at its Yorkrun mine, Connellsville, Pa., three 400-kilowatt Bullock alternating current generators for direct connection to engines, one 50-kilowatt type exciter, one exciter set, consisting of one 50-kilowatt generator direct coupled to a 75 horse power induction motor, three 200-kilowatt rotary converters, nine oil filled self-cooling 75-kilowatt transformers and one switchboard complete.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

INGERSOLL-SERGEANT DRILL CO., New York.—Catalogue 340 entitled "The Blue Book of Air Compressors." It describes briefly the standard classes of Ingersoll-Sergeant air compressors, illustrating them with well printed half-tones. 5 by 7 in., pp. 32. Also Bulletin No. 2001, issued by their pneumatic tool department, illustrating and describing the "Little Jap" hammer drill. 6 by 9 in., pp. 20.

Balanced Rolls.

STURTEVANT MILL CO., Boston.—Leaflet containing an illustration and description of the Sturtevant balanced rolls. 8 by 9 in., pp. 6.

Ball Bearings.

HESS-BRIGHT MFG. CO., Philadelphia.—Two catalogues devoted to ball bearings for cranes, hoisting engines, pumps, motors, dynamos, etc. Contains tables giving dimensions, etc. Well illustrated. 6 by 9 in., pp. 26.

Chains.

ONEIDA COMMUNITY, LTD., Oneida, N. Y.—Catalogue No. 27A, describing the many styles of chains manufactured by this company. Contains numerous illustrations, together with lists giving sizes, prices, etc. 6 by 9 in., pp. 100.

Coal-Handling Machinery.

C. W. HUNT CO., West New Brighton, N. Y.—Catalogue 055 containing a well-illustrated description of coal handling machinery for power stations, boiler rooms, coaling stations, gas companies, coal yards, shipping docks and manufactories. 6½ by 9 in.; pp. 56.

Cone Pulleys.

MOORE & WHITE CO., Philadelphia.—A very attractive catalogue containing a brief but comprehensive description of their patented transformed cone pulley. They have also included tables giving the speeds of the various sizes, their horse powers, weights and dimensions. 6 by 9 in.; pp. 20.

Cost Keeping, etc.

MILLER & FRANKLIN CO., Boston.—A series of bulletins, issued monthly, discussing many phases of system and production engineering. The argument is serial, and presents many new and strong arguments for the systematization of office and shop.

Cranes.

PAWLING & HARNISHFEGER, Milwaukee.—Catalogue describing the different styles of cranes and traveling electric hoists manufactured by them. The publication contains numerous illustrations, not only of the machines manufactured by this company, but also installations in which they are employed. Also contains a list of users. The catalogue is handsomely designed and the press-work is well executed. 12 by 9 in., pp. 140.

Electric Drills.

CINCINNATI ELECTRICAL TOOL CO., Cincinnati.—Leaflet illustrating and describing their portable electrical drill, with table showing drill dimensions. Also contains an illustration and description of their electrical grinder. 6 by 9 in., pp. 8.

Electric Locomotives.

GENERAL ELECTRIC CO., Schenectady.—Well printed catalogue treating of electricity on steam railroads for high speed service. Contains tables showing the operating cost of freight service—steam and electricity. Illustrated. 8 by 10½ in., pp. 28. Bulletins Nos. 4404, 4405, 4406 illustrating and describing slow and moderate speed, alternating current and induction motors respectively.

Electrical Apparatus.

NATIONAL ELECTRIC CO., Milwaukee.—A handsomely illustrated catalogue entitled "Plants and Types" showing a few recent installations and views of their electrical apparatus. 6 by 9 in., pp. 32.

ELECTRIC MACHINERY CO., Minneapolis.—Bulletin No. 56, devoted to illustrating and describing their revolving field alternators and rotary converters. 8 by 11 in., pp. 8.

Electrical Supplies.

BRYANT ELECTRIC CO., Bridgeport, Conn.—Catalogue illustrating and describing sockets, rosettes, switches, cut-outs, and other electrical supplies. 4 by 6½ in., pp. 210.

Fan Motors.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg.—Two artistic booklets illustrating and describing alternating and direct current fan motors. Also contain lists giving sizes, prices, volts, etc. 3½ by 6 in., pp. 20.

Files.

G. & H. BARNETT CO., Philadelphia.—In a tastefully produced catalogue many illustrations of the different sizes and styles of files and rasps manufactured by this company are included. 5 by 7 in., pp. 58.

Flexible Shafts.

STOW MANUFACTURING CO., Binghamton, N. Y.—Catalogue No. 10, containing a well illustrated description of the Stow flexible shaft for portable drilling, tapping, reaming, wood boring, emery grinding, etc., driven either by electric motor or rope transmission. 6 by 9 in., pp. 76.

Furnaces.

AMERICAN COKE & GAS CONSTRUCTION CO., New York.—Well printed booklet describing the advantages of the O'Brien mechanical desulphurizing furnace as compared with any other furnace. 6 by 9 in., pp. 8.

Generators.

CROCKER-WHEELER CO., Ampere, N. J.—Bulletin No. 52, devoted to describing and illustrating their railway generators. Also contains illustrations of recent installations. 7 by 10 in., pp. 12.

NORTHERN ELECTRICAL MFG. CO., Madison, Wis.—Bulletin No. 46 contains a description of their direct connected generators. The pamphlet contains numerous illustrations, which show not only the machines built by them, but also views of recent installations.

Hydraulic Rams.

COLUMBIA ENGINEERING WORKS, Portland, Ore.—Catalogue illustrating and describing hydraulic rams and auxiliary equipment especially adapted for irrigation, hydraulic mining, railroad tanks, manufacturing, etc. Contains tables giving sizes, weights, prices, etc. 6 by 8 in., pp. 56.

Inspirator.

HANCOCK INSPIRATOR CO., New York.—Large, handsome catalogue, bound in cloth, illustrating and describing the complete line of locomotive and stationary inspirators manufactured by this company. Steam valves, check valves, hose strainers, blow off valves, whistles, cylinder cocks, guide oil cups and globe valves are also illustrated and described. Also contains tables giving sizes, prices, etc. 9 by 12 in., pp. 112.

Insulators.

LOCKE INSULATOR MFG. CO., Victor, N. Y.—Catalogue No. 8 contains illustrations of porcelain and glass insulators with tables giving the dimensions of each. Insulator pins and brackets are also treated. 6 by 9 in., pp. 56.

Pumps.

GOULDS MFG. CO., Seneca Falls, N. Y.—A neat little pamphlet printed on tinted paper illustrating and describing the full line of power pumps manufactured. 3½ by 6 in., pp. 12.

Superheated Steam.

POWER SPECIALTY CO., New York.—"Superheated Steam" is the title of a pamphlet describing the advantages of superheating and the various uses to which it is applicable by means of the Foster superheater. Also contains tables giving much valuable data. Illustrated. 6 by 9 in., pp. 32.

Water Gas Apparatus.

GAS MACHINERY CO., Cleveland.—Bulletin No. 192, fully describing the apparatus employed for producing carburetted water gas. Well illustrated. 6 by 9 in., pp. 28.

Water Gauges.

WM. T. BONNER CO., Boston.—Booklet containing an illustrated description of the reflex water gauge for land and marine boilers, automobiles, tanks, separators, etc., together with illustrations of gauge mountings. 4 by 7½ in., pp. 20.

Well Machinery.

ST. LOUIS WELL MACHINE & TOOL CO., St. Louis.—Bulletin E contains a description of the St. Louis center beam driller, together with illustrations showing the driller at work. Bulletin P treats of pipe and casing supplies. Illustrated. 7½ by 10 in.

NEWS SUPPLEMENT

The Engineering Magazine—July, 1905

Personal.

—Irving H. Reynolds has been elected vice-president and general manager of The William Tod Co., Youngstown.

—W. S. Heger, formerly associated with the Westinghouse interests, has joined the Allis-Chalmers Co., becoming assistant to the vice-president and general manager.

—W. P. Culver, formerly with the Cleveland Motor Car Co., is now the Eastern representative of the Diamond Chain & Mfg. Co., Indianapolis, with headquarters in New York.

Industrial Notes.

—The Reeves Engine Co. announces that they have moved their Chicago offices from 1612 Monadnock Block, to more desirable quarters at 355 Dearborn Street.

—The Manufacturers' Advertising Bureau, New York, have just published the fifth edition of "Advertising for Profit," which describes service performed by the Bureau.

—The Franklin Institute has awarded to the Cleveland Cap Screw Co., Cleveland, the John Scott legacy premium and medal for the superiority of their system of electrically welding the heads of screws to the bodies.

—The locker manufacturing plant of Merritt & Co., Camden, N. J., was visited by fire recently, but the damage was confined to the paint rooms, shipping department and one stock room. There will be no delay in filling orders, however, as the manufacturing plant was not injured at all.

—The passenger department of the Delaware, Lackawanna & Western R. R. has just issued the 1905 edition of the mountain and lake resorts along this road, together with a list of the hotels and their rates. The book is well printed and handsomely illustrated with fine half-tones showing views of the scenery at the various resorts.

—Warren Brothers Co., Boston, has been awarded the contracts for paving the following streets with bitulithic pavement: Main Street, Worcester; Medford and Pearl Streets and Gilman Square, Somerville, Mass.; Spring and Portland Streets, Cumberland and Pleasant Avenues, Portland, Maine; Bismarck Avenue, Gerrard and Charles Streets and Dunbar Road, Toronto; and to the Central Bitulithic Paving Co., Detroit, a contract for bitulithic pavement in Boxboro Street, Toronto.

—Manning, Maxwell & Moore, New York, and its allied manufacturing companies, Shaw Electric Crane Co., Ashcroft Manufacturing Co., Consolidated Safety Valve Co., Hayden & Derby Manufacturing Co., Hancock Inspirator Co., and the United Injector Co., were incorporated under the laws of the State of New Jersey with a paid-up capital of $5,000,000. The corporation will be known as Manning, Maxwell & Moore, Incorporated, and business will be carried on at the home office, 85-89 Liberty Street, New York, and through their branch offices in Boston, Philadelphia, Chicago, Cleveland, Pittsburg and St. Louis.

—J. W. Duntley, president of the Chicago Pneumatic Tool Co., returned recently from Europe, where he has spent the last six weeks in the interest of the company. He brought orders with him for 3,400 tools for shipment from America, and states that owing to the growing demand for pneumatic tools in England and on the Continent, it was found necessary to extend the organization of the foreign business. With that end in view, the factory and business of E. G. Eckstein, Berlin, and that of Leucke & Co., St. Petersburg, were purchased and will be operated for the purpose of meeting these requirements in the continental countries.

—Rand Drill Co., New York, has just issued "Air Power" for July, and it contains among other things a complete description, illustrated by diagrams, of a displacement pump, written by Professor E. G. Harris; a description of a recent installation of a Compressed Air Mine Haulage System by A. A. Bowman, M. E.; The Uses of Compressed Air in the Wood-Working Shop by W. R. Hulbert, M. E.;

a description of the Construction of the New Duluth Aerial Bridge; an article on the Philadelphia High Pressure Pumping Plant; a practical article on Air Compressor Foundations by E. M. Mackie, M. E.; three new inventions as follows—A New Tunnelling Machine, a Pneumatic Stake Driver used by Barnum & Bailey, and a device for conveying hot rivets through a metal tube by compressed air. The rest of the paper is made up of short paragraphs containing odds and ends of useful information which will be of great interest to manufacturers and consumers alike.

—Mead-Morrison Manufacturing Co., Boston, has recently closed the following contracts: Brooklyn Union Gas Co. (Metropolitan Works), a coal unloading plant, making five plants installed for this company; Queensboro Gas & Electric Co., a very complete system for the unloading of coal from boats. This plant consists of an unloading rig and a shuttle cable road; Bridgeport Malleable Iron Co., a comprehensive system for unloading their coal, coke and sand from railroad cars and depositing in storage pockets, sheds and piles. They have also furnished two powerful electric storage battery locomotives for handling their product through their yards and buildings; Interboro Rapid Transit Co., for a coal and ash handling equipment, which includes an unloading tower of the latest type and four McCaslin conveyors at their 59th street and North River power station; and the Canadian Northern Dock Co., a very large unloading and storage system at Port Arthur. This will be one of the largest plants built in the Northwest.

—The Ingersoll-Sergeant Drill Co. and the Rand Drill Co. have been united into a new company called the Ingersoll-Rand Co. The new corporation was formed under the laws of New Jersey with a capital of $10,000,000, of which $5,000,000 is preferred stock and the balance common. The factories of the two companies are located at Phillipsburg, N. J.; Easton, Pa.; Tarrytown, N. Y.; Ossining, N. Y.; Painted Post, N. Y.; 34th street, New York; and Sherbrooke, Quebec, and they will all be operated. The officers of the Ingersoll-Rand Co. are as follows: President, W. L. Saunders, formerly president of the Ingersoll-Sergeant Drill Co.; first vice-president, George Doubleday, formerly treasurer of the Ingersoll-Sergeant Drill Co.; vice-presidents, Jaspar R. Rand, formerly president of the Rand Drill Co.; John A. McCall, president of the New York Life Insurance Co.; J. P. Grace, vice-president of W. R. Grace & Co.; George R. Elder, general manager of the manufacturing department; treasurer, W. R. Grace, formerly secretary of the Ingersoll-Sergeant Drill Co.; secretary, F. A. Brainerd, formerly treasurer of the Rand Drill Co. For the present the main offices of the new company will be located at 26 Cortlandt street, New York.

—Westinghouse Electric & Manufacturing Co., Pittsburg, report the following orders: Newcastle Portland Cement Co., New Castle, Pa., for two 175 kilowatt, three-phase, alternating-current generators, two 42 kilowatt exciters, and the necessary switchboard for the control of this apparatus. These machines will supply current for operating a number of type C induction motors, ranging from 10 to 100 horsepower each, which were also included in the contract: Western Engineering & Construction Co., ordered 180 horse-power in type F, variable speed, induction motors, 130 horse power in type C, constant speed induction motors, and four O. D. transformers; Cleveland Electric Railway Co., one 1,500 kilowatt, 500 volts, direct-current, engine type generator and switchboard; Cincinnati Traction Co., eight quadruple equipments of No. 85 motors with unit switch group control, four No. 85 quadruple equipments with 2-L-4 controllers, and four No. 93-A quadruple equipments with 2-K-4 controllers. The No. 85 motor has a nominal rating of 75 horse power, and the 93-A motor has a capacity of 60 horse power; and the Consolidated Railways Co., New Haven, will equip fifteen cars with four No. 93-A motors each and 2-K-6 controllers. The same order included twenty-six No. 101-B motors with K-10 controllers and seventeen equipments of No. 110-B motors and K-6 controllers.

—The Allis-Chalmers Co., Milwaukee, announce that they have closed the following contracts: Twin City Rapid Transit Co., Minneapolis, a vertical cross compound Reynolds-Corliss condensing engine, for

direct connection to a 3,500-kilowatt 3-phase alternating current generator; Florida East Coast Railway, St. Augustine, two horizontal reliance engines, and a Bullock alternating current generator, with exciter; New Castle Portland Cement Co., New Castle, Pa., four rotary kilns, each 100 feet in length and 7½ feet in diameter at the large and 6½ feet at the small end, one No. 6 Gates rock and ore breaker, two No. 4 Gates breakers and one No. 6 elevator; Champion Copper Co., Chicago, a vertical cross compound Reynolds-Corliss condensing engine of 340 horse power; Arizona Smelting Co., Prescott, Ariz., an electrically operated converter and two reverberator furnaces with auxiliary apparatus; Tacoma Smelting Co., Tacoma, a steel water jacketed blast furnace for treating copper ores, the dimensions of which are 42x160 feet at the tuyere line; Delaware and Hudson Coal Co., Scranton, four horizontal Reynolds-Corliss girder frame engines. They will be used to operate two 28-feet fans for mine ventilators; Republic Iron and Steel Co., Youngstown, one horizontal cross compound condensing Bessemer blowing engine. The high-pressure cylinder will be 46 inches in diameter, the low-pressure cylinder 88 inches and the two air cylinders of 76 inches effective diameter. The stroke is to be 60 inches. The engine will be capable of delivering 24,000 cubic feet of free air per minute at a pressure of 28 pounds per square inch; Harbinson & Walker Refractories Co., Pittsburg, one heavy duty horizontal Reynolds-Corliss belted engine, with cylinder 22 inches in diameter and a 42-inch stroke; and the city of Hastings, Neb., for an equipment of an electric lighting plant. The generating unit will consist of a heavy duty cross compound Reynolds-Corliss engine, with cylinders 14 and 22 inches in diameter and a 36-inch stroke, direct connected to a 222-kilowatt single-phase Bullock alternator. The generator is to be provided with an exciter, rheostats and other auxiliary apparatus, and a switchboard panel will be installed.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Chicago Pneumatic Tool Co., Chicago—Illustrated catalogue describing the different types of Franklin air compressors manufactured. Air receivers are also treated. Contains tables giving much valuable data. 6 by 9 in., pp. 28.

Laidlaw-Dunn-Gordon Co., New York—Catalogue L 150 describing and illustrating a complete line of steam, electric, gas and power-driven compressors of all types, including single and duplex and simple and compound; single and multi-stage, etc. It gives the results of the latest investigations upon air-valve gears, and shows a gear combining the quietness, efficiency and high speed qualities of mechanically-moved valves with the elasticity of poppet valves. 6 by 9 in.; pp. 175.

Car Coupling.

McConway & Torley Co., Pittsburg—A handsomely illustrated pamphlet entitled "The Evolution of Car Couplings," printed in both English and French, containing much historical matter of interest to railway people. This pamphlet was distributed at the International Railway Congress recently held at Washington, D. C.

Coal Handling.

The Wellman-Seaver-Morgan Company, Cleveland Ohio—Catalogue of ore and coal handling machinery, including also unloaders, cranes, car-dumping machinery, and excavating buckets. This is a remarkably handsome publication, giving views of the works at Cleveland and at Akron, showing the extensive equipment and complete facilities for high-class work, followed by illustrated descriptions of the Hulett automatic unloaders, of unloading and reloading bridges, conveyors and cranes. The Hulett car dumpers are shown as operated at a number of important coal and ore handling terminals, while the various applications of excavating buckets give an excellent idea of the value of these powerful machines. Catalogues of this sort might properly be described as engineering treatises upon the special subjects to which they are devoted than as ordinary trade publications.

Digging Machinery.

The Hayward Co., New York—Booklet entitled "Digging Machinery" intended for those interested in machinery for general contracting purposes. In it are embraced illustrations of the different types in which the Hayward orange-peel and clam-shell buckets are built, as well as a number of machines by which they are operated. The booklet is gotten up in a most convenient form for ready reference. 6 by 3½ in.; pp 32.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia—Catalogue illustrating and describing the full line of drawing instruments manufactured by this company. Contains tables giving the different sizes in which the instruments are made and the prices of each. 5 by 8 in.; pp. 108.

Drawing Stands.

The Washburn Shops, Worcester—Catalogue D illustrating and describing adjustable drawing stands for draftsmen, engineers, architects, schools, etc., giving the dimensions and price of each.

Electric Fans.

Crocker-Wheeler Co., Ampere, N. J.—Booklet entitled "A Few Words about Electric Fans" illustrating and describing the different styles of electric fans manufactured by them. 5 by 8 in.; pp. 8.

Electrical Apparatus.

Westinghouse Electric & Mfg. Co., Pittsburg—Circular No. 1102 devoted to direct current multiple arc lamp for 110 and 220 volts; circular No. 1104 illustrates and describes portable testing instruments. 6 by 9 in.

Feed Water Heaters.

Warren Webster & Co., Camden, N. J.—Part V general catalogue descriptive of the Webster system of steam circulation for heating purposes. Contains numerous illustrations showing recent installations. 6 by 9 in.; pp. 64.

Injectors.

Hayden & Derby Mfg. Co., New York—Booklet describing the different styles of injectors manufactured, together with tables giving dimensions, capacities and prices. Ejectors are also illustrated and described. 4 by 6 in.; pp. 48.

Machine Tools.

Niles-Bement-Pond Co.—"Progress Reporter" for May contains illustrations, together with a brief description, of all the new machines and devices brought out recently by the above company. 9 by 1 in.; pp. 20.

Manila Rope.

C. W. Hunt Company, West New Brighton, New York—Catalogue No. 054, being a treatise on manila rope for transmission and for hoisting purposes. By C. W. Hunt. While this is issued as a trade catalogue it is really a technical treatise for the use of engineers and manufacturers on ropes used for the transmission of power, together with formulas, tables and other data useful in mill engineering. The pamphlet contains a brief history of rope making and a glossary of technical terms relating to the subject, followed by a scientific study of rope transmission, with formulas and tables for the computation of power transmitted, effect of centrifugal force, and the proper forms for rope sheaves. The appendix contains papers upon rope driving and upon working loads for manila rope, contributed by Mr. Hunt to the Transactions of the American Society of Mechanical Engineers, together with data of official tests of rope in the United States and in Europe. 6½ by 9 in.; pp. 52.

Motors.

Northern Electrical Manufacturing Co., Madison, Wis.—Bulletin No. 44 illustrates representative applications of back-geared motors in industrial plants for operating slow speed machines.

Pumps.

Dayton Hydraulic Machinery Co., Dayton—"Why" is the title of a bulletin devoted to an illustration and description of the Brooks' centrifugal pump. Contains tables giving capacity, etc. 6 by 9 in.; pp. 16.

Weinman Machine Works, Columbus, Ohio—Pamphlets containing an illustrated description of pumps for mines, boiler rooms and artesian wells. Contains tables showing capacities. 3½ by 6 in.; pp. 14.

Radiators.

National Radiator Co., Johnstown, Pa.—Catalogue and price list illustrating and describing radiators, boilers, tanks, heaters and other specialties manufactured by them. Also contains tables giving sizes, etc. 4½ by 7 in.; pp. 96.

Railway Block Signals.

General Electric Co., Schenectady, N. Y.—Catalogue describing an improved system of electrically operated automatic block signals for use on steam railroads. Contains many illustrations showing the mechanism of the signals. The catalogue is well printed. 8 by 10½ in.; pp. 20. Bulletins 4408 and 4409 fully illustrate and describe 125-250 and 600 volt continuous current two-wire switchboard and panels with carbon break circuit breakers and electrically driven turbine house pumps. 8 by 10½ in.

Recording Thermometers.

The Bristol Co., Waterbury, Conn.—In catalogue No. 28 the recording thermometers are classified according to the principles upon which they depend for their operation. The lists of these different classes of thermometers, which cover all ranges to 1200 ° F., have been carefully arranged with special reference to make it convenient for a prospective user of these instruments to easily select one which would be best adapted to meet special conditions. Illustrated. 9 by 12 in.; pp. 48.

Water Power.

Pelton Water Wheel Co., San Francisco—An extensive catalogue treating in detail the question of water power and hydraulic machinery, from the small wheel for running a mill to the equipment of a hydro-electric central station. The many tables contain facts likely to be needed at any time, and are well worth preserving for reference. 6 by 9 in.; pp. 108.

Water Wheel Governors.

Replogle Governor Works, Akron, Ohio—Catalogue giving a general idea of the capacity and characteristics of the new mechanical relay governors. Is well illustrated. 6 by 9 in.; pp. 20.

Wire Glass.

Mississippi Wire Glass Co., New York—A series of pamphlets containing reprints of articles that appeared in the Insurance Press and the Philadelphia Intelligencer and papers read by Perez M. Stewart and Harry W. Gue treating of wire glass as a fire retarding agent.

IMPROVED MACHINERY

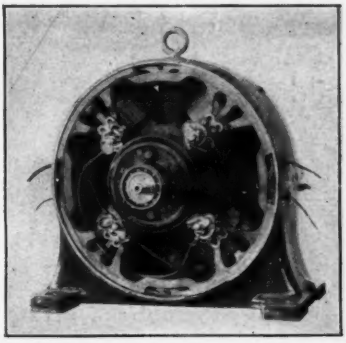
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Inter-Pole Variable-Speed Motors.

THE Electro-Dynamic Company, Bayonne, N. J., has placed upon the market a new variable speed motor which can also be used for constant speed work as well. This motor can be set to run at any speed between 275 and 1,400 revolutions per minute, and will maintain this set speed without any perceptible variation, whether operating under no load or full load. By the use of the inter-pole this motor has perfect commutation when running in either direction and at any load from no load to 100 per cent. overload, is simple in control and has very high efficiency under all conditions. It is especially adapted to machine tools of all descriptions, pumps, ventilating fans, laundry machinery, and in fact all kinds of machinery, driving them either directly or in groups.

FRONT DIAGONAL VIEW OF INTER-POLE MOTOR.

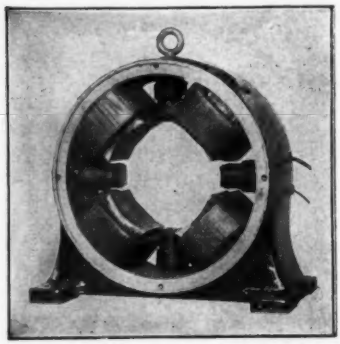


MOTOR WITH FRONT BEARING REMOVED.

The main feature in the motor is of course the inter-pole; centred 90 degrees between each of the four main poles, being considerably smaller and are in series with each other and the armature. In any direct-current, shunt-wound motor having a variable speed, the strength of the main field poles must be decreased in proportion if the rotation be increased. Sparking at the brushes will be the result, and if an attempt is made to fit the motor to run in either direction by changing the brushes to positions equidistant between the poles, the sparking will be further increased. In this motor, however, by the use of the inter-poles, the brushes are placed equidistant between the auxiliary poles, thus making it capable of reversing its direction of rotation without sparking with variable load as well as with variable speed. The motor operates on a two-wire service, direct current from 110 to 500 volts.

The coils in the auxiliary poles are so proportioned as to give the proper field commutation, and as these coils are in series with the armature, weakening the field of commutation by increased load is prevented, and the auxiliary poles produce a compensatory field of commutation independently of the main field, which is weakened with an increased number of revolutions of the armature. The function of the auxiliary poles is independent of the direction of rotation of the armature, for if the latter is reversed, the current in the auxiliary field is also reversed. Another and

important feature of this motor is the use of ball bearings in place of the ordinary journal bearing. It consists of two races, one of which is fastened to the bearing housing and the other to the armature shaft. Between each ball is placed a spring



VIEW OF MOTOR FRAME, BOTH BEARINGS AND ARMATURE REMOVED, ILLUSTRATING CLEARLY THE INTERPOSED POLES

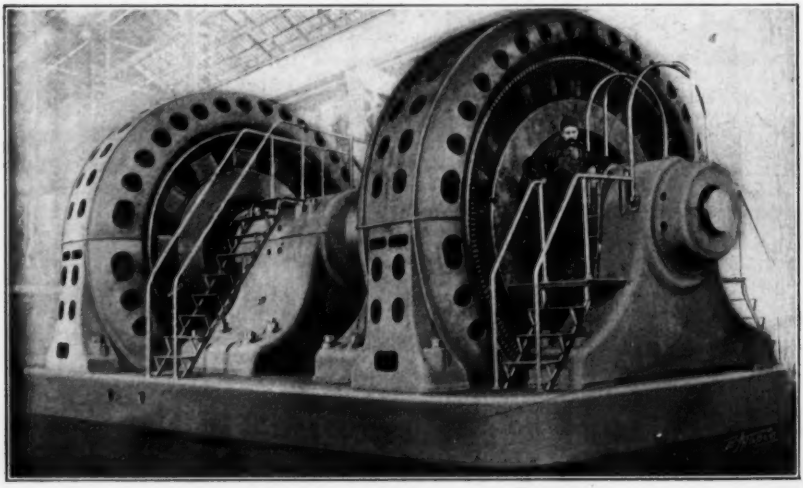
separator which is packed with mineral wool, the duty of the mineral wool being to take up the lubricant and to feed it to the bearing gradually. Thus the attention required in oiling an ordinary motor is obviated and the only requirement in this line is the occasional renewal of lubricant. The makers will furnish particulars on request.

An 8,000 Horse-Power Motor.

THE largest electric motor ever built is now being installed at the plant of the Shawinigan Water & Power Co., Shawinigan Falls, Quebec. This was recently constructed by Allis-Chalmers Co. at their electrical works in Cincinnati, and embodies in its design the characteristics of the Bullock alternators, which have proven singularly successful in their application. It is a synchronous motor of 8,000 horse power. The rating of the generator operated by this motor, on standard specifications, is 5,750 kilowatts at 300 revolutions per minute. The combined machines, in addition to their enormous capacity, are remarkable for concentrating in an exceedingly small floor space a volume of 12 000 kilowatts. The photograph of the machines, which is shown herewith, was taken while they were being tested at the shops, by the Behrend system, under full load conditions corresponding to 7,200 kilowatts on the generator, with the expenditure of no more than 300 kilowatts in order to produce the same losses in the machine which exist under full load conditions.

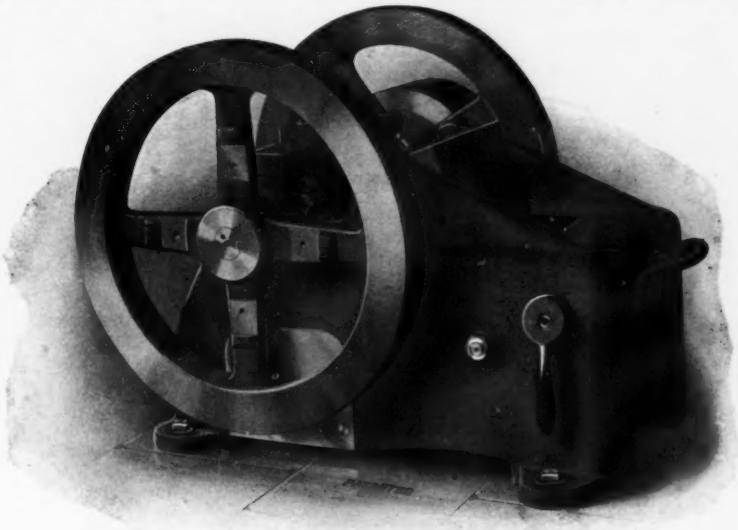
Sampling Outfits.

THE Sturtevant Mill Co., Boston, Mass., have added to their line of regular product a laboratory fine crusher and a sample grinder. The laboratory fine



EIGHT THOUSAND HORSE POWER MOTOR.

crusher is built on the same lines as the large crushers of this type, with the exception of its special adaptability to cleaning. The machine is built in two sizes, with jaw openings 2″ x 4″ and 2″ x 6″. The one illustrated is the 2″ x 6″ size,



LABORATORY FINE CRUSHER.

which weighs about 600 pounds, has a capacity from 250 to 600 pounds per hour, crushing to sand size without screens. The front head and stationary jaw may be easily and quickly removed when both crushing surfaces are exposed for perfect cleaning after each sample. The jaws and shields are of manganese steel, the toggles of bronze, working in tool steel seats, in fact every part is made of the best material to produce a first-class machine. It is built for especially fine work and will crush the hardest ores to ⅛″ and finer without clogging. The 2″ x 4″ crusher may be run by hand or power if desired.

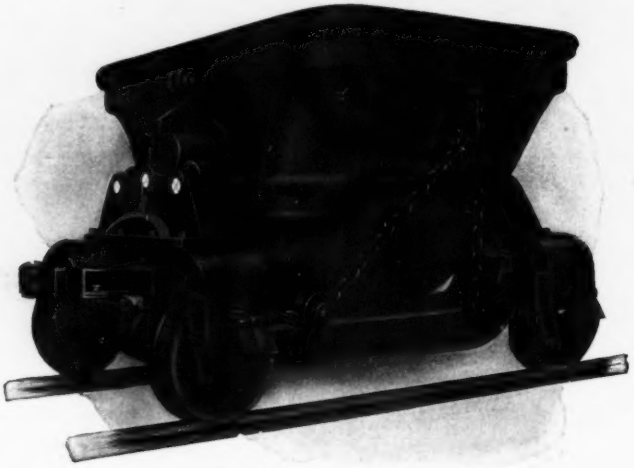
The special sample grinder will take the product from these crushers, or reduce hard or soft ore crushed to ¼″ and finer to 200 mesh without screens. It is adjustable for coarser work by simply turning a hand wheel, and produces a very even product to any fineness, without screens being used.

Dewhurst Slag Ladles and Cars.

THE Wellman-Seaver-Morgan Company, Cleveland, have sole American rights for the manufacture and sale of the Dewhurst slag ladles and cars. These ladles embody a number of distinctive features which will be noted by reference to accompanying illustrations. Hand tipping is done away with, thus reducing the cost of operation, and increasing speed. The tipping device is at once simple and efficient. The ladles are tipped by a pull of the locomotive on the tipping chain. There are no power cylinders, gears, or tipping poles required. The chain and tipping mechanism for side tipping ladles can be placed on whichever side of the car the dumping is to be done. The chain runs over steel snatch blocks and guide pulleys; the latter and two of the snatch blocks being attached to car, and the other snatch block being attached to the ladle as shown. The chain is provided with hooks at each end; one for hooking to the car and the other for hooking to the locomotive. This chain may be hooked to either end of the car, as required. The locomotive pulls away from the ladle while dumping. Hence if the chain should break, the locomotive is

not endangered, but will run away from the ladle instead of toward it. When the slag has been dumped. the ladle rights itself by gravity, by merely backing the locomotive. A train of side tipping ladles can be tipped in series by attaching hook of each ladle to car ahead of it. The end tipping ladles are tipped by a direct pull of the locomotive from the opposite end of car, the locomotive pulling away from car. On all ladles a forged steel band is attached, running around the ladle slightly below the rim. By means of this band, the pull is evenly distributed around the ladle, thus obviating any tendency of the pull to cause the ladle to spring outward at the front. By fixing the tipping point high on the ladle, the leverage is increased and the tipping process made proportionately easier.

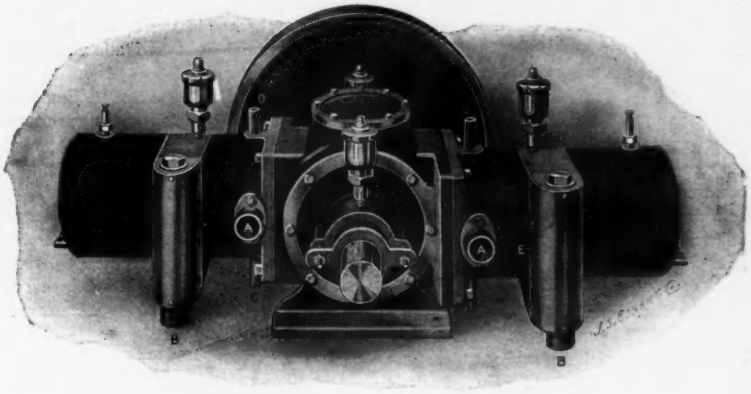
Double trunnions are cast on each side of the ladle, being located slightly above the axis, so that the ladle will right itself from any point to which it might be tipped. Roller bearings are provided on which the trunnions rest, thus greatly reducing the power required for tipping. The ladles are of special shape, to facilitate the stripping of the slag and skull. Hence, in dumping the skull follows the molten slag, requiring no hand work for its removal. The whole of the work is handled by the locomotive and its crew. The ladle is cast in a single piece, and heavily ribbed on the outside to stiffen it and increase its strength. There are no ladle linings to require renewal. The absence of linings also obviates all possibility of the skull pulling out the linings and taking it with it in dumping. Cars are built for standard gauge tracks, and are equipped with either four or eight wheels, as may be required. They are built in a variety of sizes, ranging in capacity from 70 to 280 cubic feet inside dumping pattern, and from 70 to 210 cubic feet in end dumping patterns, the 210 cubic foot car of each being the standard size. Further details will be furnished by the builders, on application.



DEWHURST SLAG LADLE AND CAR.

The Excelsior Gasoline Engine.

THIS engine is built in two distinct types: the horizontal opposed and the vertical, and is a two-cycle engine for marine work, embodying all the good features of the best marine engines, such as spark-plug ignition, no valves coming in contact with the fire to give trouble, receiving charge through induction port, carburetor instead of vaporizer. In addition, these engines have several features of their own, such as automatic reversing device, adjustable bearings made of bronze, great



EXCELSIOR GASOLENE ENGINE.

speed range, arrangements to prevent back firing in crank-case, high compression (giving great efficiency), semi-automatic grease lubrication throughout, and the use of ground joints instead of packing. The greatest care and attention has been given to the correct proportioning of all parts for strength and selection of material for the greatest wear. This has enabled the builders to produce a perfectly reliable engine, durable, economical, light, compact, and powerful.

To reverse this engine all that is necessary is to throw over the lever, as in a steam engine, and the engine will reverse itself automatically. This is a very important feature, when one person is alone in handling a boat, as it gives time for attention to other things. Since the auxiliary engine is becoming almost a necessity in a sailboat used for business or pleasure, the remarkably small amount of fuel used, and the lightness of the engines, with their adaptability for this particular work and automatic reversing device, would recommend the Excelsior gasoline engine.

These engines are furnished complete with all accessories, or the engine alone, as preferred. The builders, however, recommend that the purchaser buy the engine complete, with propeller, shaft, stern bearing stuffing-box, and muffler, as the parts are made specially for the engine and the best possible results can be obtained from them.

Further particulars may be had from Julian d'Este Company, 24 Canal Street, Boston, Mass.

Flexible Steel-Armored Hose.

A DEMAND for a steam or air hose which could be absolutely relied upon has led the Sprague Electric Company to enter the field with a new product which exactly meets the requirements of the train master, the mechanic and the quarrymen. The Sprague company's new product is known as "flexible steel-armored" hose and consists of a suitable rubber hose encased in a steel armor which prevents expansion and thus greatly increases the life of the hose. It also protects the hose from mechanical injury and insures flexibility by making it impossible to flatten or kink when handling. Ordinary rubber hose, when over-vulcanized, is likely to burst, whereas if a crack should occur through

FLEXIBLE STEEL-ARMORED HOSE.

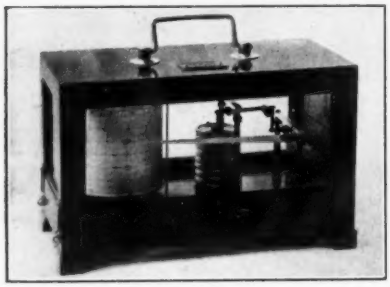
over-vulcanization in the "flexible steel-armored hose," the steel armor binds the rupture so tightly that very little pressure is lost and the work in progress need not stop.

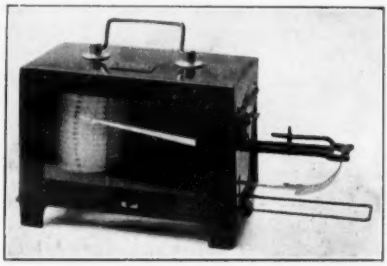
The accompanying illustration shows the general appearance of the hose. The manufacturers have issued a descriptive bulletin numbered 5057 which will be sent upon request, by addressing the Sprague Electric Company, 527 West 34th Street, New York.

American Made Barographs and Thermographs.

THE making of barographs and thermographs by Queen & Co., Philadelphia, is an advance step in the American manufacture of scientific instruments. As shown by the illustration, they follow the general line of European instruments, embodying, however, several new ideas which have been introduced by the manufacturers. The purpose has been to simplify the mechanical arrangements of the instrument, thereby obtaining a greater degree of accuracy in manipulating them. The adjusting screw of the barograph has been removed to the front, which enables the operator to set the pen without lifting the instrument, thus ensuring a greater degree of accuracy. Also, the small lever used to raise the pen from the paper does not protrude beyond the case. This is an important improvement, as it prevents the possibility of accidentally pushing the lever to one side and so stopping the record of the instrument for any length of time. The barograph is mounted in a handsome case, having three glass sides, thus admitting abundance of light and allowing the chart to be easily read.

The valuable features of improvement in the thermograph are: the case and finer adjustments of the clock are made of aluminum, and a change of temperature from the lowest to the highest of the scale will not affect its running. The lever raising the pen from the paper is fitted within the case. These instruments have been submitted to severe tests and in every case have proved equal if not superior to the foreign article.





QUEEN BAROGRAPH AND THERMOGRAPH.

A Departure in Direct Current Motor Construction.

A MOTOR known as the Lundell Universal, manufactured by the National Electric Company, Milwaukee, has just been placed upon the market, which in design is a radical departure from anything that has been made before. The component parts are proportioned and combined to produce machines remarkable for their efficiency, low temperatures, compactness and rigidity of structure. This motor differs in external appearance from the ordinary type of motor in that the yoke is of laminated steel rings contained and rigidly supported in a cast iron frame. The frames when bolted together possess an exceptional stiffness, which is in no way dependent upon the laminations, the arrangement being such that it makes no difference to the stability; and perfect alignment of the machine is not dependent on the yoke lamina-

tions. The pole pieces are also built up out of laminations. The armature is constructed of laminations in the usual way, but in the machines up to 60 horse power it has been found that it is not necessary to introduce ventilation into the center, as the losses are exceptionally low in this type of machine. This gives an exceptionally short armature. The use of laminated mild steel for the entire magnetic circuit in yoke, pole pieces, and armature body insures an absolute uniformity of the magnetic circuits, with a consequent greater flexibility of speed control, quick field regulation, and a more compact structure.

NORTHERN DIRECT CURRENT MOTOR.

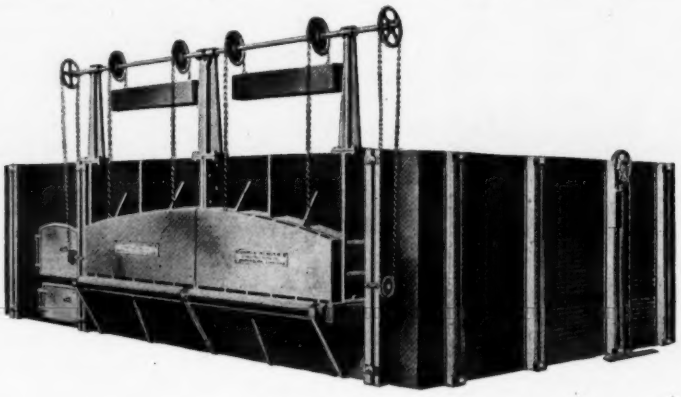
A new principle is involved in the brush holder design. In each holder the brushes are placed in tandem, instead of side by side as is usually done. This is of great value especially in variable speed work, or for other conditions that necessitate severe commutating conditions. In such instances the brush at the leaving edge is made of high resistance carbon to take care of the sparking conditions, and the other of material of high conductivity to carry the current. With this new brush holder the total brush surface is the same as is the commutator space occupied by the usual side-by-side brushes, and each brush has its independent tension spring. With the old style brushes any irregularity of a commutator surface caused both brushes to jump together, thus momentarily opening the circuit at that point as each irregularity passed a brush holder. With this new tandem brush any such irregularity strikes only one brush in the holder at a time, so that while one may rise the other in the same holder is making contact, and the circuit is always kept closed at each particular holder. In practice it has been found that the use of such a brush holder materially reduces the temperature of the commutator.

This type of motor is especially suitable for variable speed work and the makers are able to obtain a ratio of three to one range of speed by field control. The variable type motors are made on the same style of frame as the constant speed machines, although of different ratings to meet the speed ranges required. These variable speed motors are remarkably compact and have ample margin for carrying overloads even when working under the most difficult conditions of commutation, important factors in their application to the direct driving of machinery. The motors are particularly short between bearings on account of the high quality of material used, and also on account of the ingenious design. Notwithstanding this short distance between bearings, the bearings themselves occupy a considerable percentage of the overall-width of the machine. The over-all dimensions (height and width) of the magnet yoke are not exceeded by any part of the cast iron frames or housings so that these dimensions are also reduced to a minimum.

A New Heating Furnace.

THE Kenworthy Engineering & Construction Co., Waterbury, Conn., have recently put on the market a furnace for the heating of plates used in flanging up boiler heads and kindred material. This furnace is designed for use in connection with flanging presses and made in a variety of sizes, the furnace shown having a heating chamber eight feet six inches square. The furnace may be equipped for the burning of any fuel—coal, oil or gas, the one illustrated being equipped for coal fuel. Attention is directed to the door construction, which consists of ventilated cast iron doors lined with magnesia, and operated by hand chains in a similar manner to the operation of chain blocks. The doors on the wider sizes of this type of furnace are divided so that material may be treated with a minimum loss of heat. These doors are easily raised and lowered with a pull of ten or fifteen pounds, thus limiting the

time which is usually required in this operation. In consequence of the ventilation of these doors, the operator can without discomfort place his hand on the doors when the furnace is running at white heat. This feature also tends to prolong the life of the doors and the front plates. Great care has been exercised in the design of this furnace to have the ironwork strongly constructed, and the fire brick parts of a standard character so that repairs may be easily and quickly made. Several sizes of this furnace are now ready and other sizes are constantly being designed.



NEW KENWORTHY HEATING FURNACE.

The builders will be glad to furnish further details upon request.

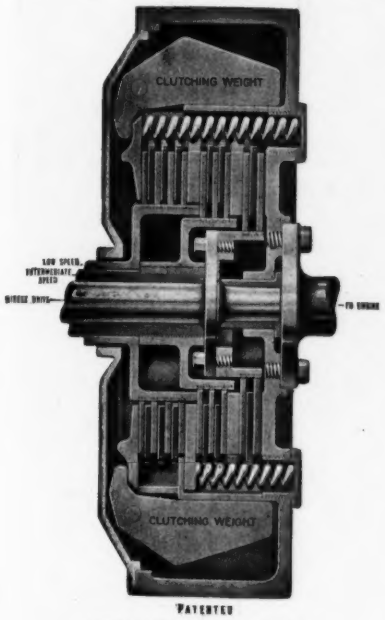
An Automatic Gear-Clutch.

THE automatic clutch shown in the accompanying illustration is designed primarily for automobiles, but will be developed by the manufacturers, the Sturtevant Mill Company, Harrison Square, Boston, for many other large and small mechanisms. These clutches allow the prime mover to start without load, and at a predetermined speed the clutches grip and drive other mechanism to which they are connected. They are adapted to transmit the largest and also the smallest powers, for by multiplying the number or size (or both) of the friction discs, they are enabled to hold motors of any class without slip.

In some Sturtevant designs the high-speed clutch is held out of engagement whenever the torque, or resistance is above a predetermined point. Thus the motor is enabled to run fast on low gears, and develop full motor power on the low-gear train. The friction discs run in oil; and the force used to press them together rarely need exceed 50 lbs. to the square inch. This is below common pressures on running bearings, since some machines carry 600 lbs. per sq. inch safely on bearings. Centrifugal clutch discs if allowed to slip (as is occasionally desirable for some purposes) do not wear more than machine bearings, and since there is practically no wear, no adjustments are required after once setting to engage at the desired speeds.

These automatic clutches are of decided advantage for many mechanisms in which a load is required to be taken on gradually. When applied to automobiles the centrifugal automatic clutch is placed in the fly-wheel, and each clutch actuates a set of gears in the gear-box. There are three changes of speed. The clutch-enclosing fly-wheel shell is of common size, and the clutches give it the necessary weight so that the apparatus weighs no more than the plain fly-wheel. The fly-wheel enclosure forms a bath of lubricating oil. Each clutch consists of a number of thin cast-iron disc plates of large diameter that are forced together to grip by the centrifugal action of the enclosed peripheral weights,

which move out by centrifugal force and press the plates together, causing a frictional engagement. Each weight is held back by springs, and it is only when the speed of rotation causes centrifugal force to overcome the springs that the weights



AUTOMATIC GEAR CLUTCH.

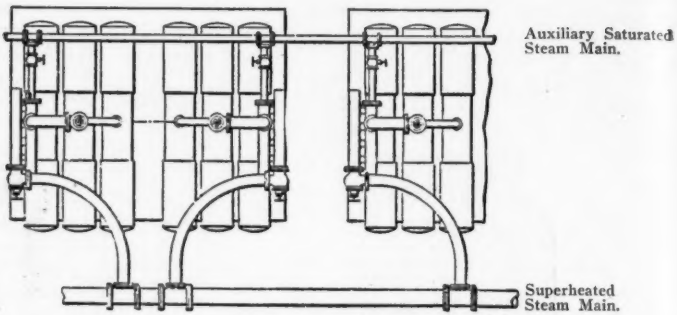
move out to cause the plates to grip. The friction plates are released as soon as the revolutions lessen sufficiently to permit the springs to force back the weights and separate the disc faces.

It can be seen from the foregoing that all gear changes are produced by changes in motor speed, and that the changes must necessarily be smooth. No shocks can be communicated to the gear teeth or chains if such are used, and the changes are made so smoothly as to be imperceptible. Since the gear-driving clutches engage at different motor speeds, it follows that if the motor speed is changed by the throttling foot-button which controls the engine, or by any other means, the gears are changed accordingly. Therefore if the motor is slowed by road resistance, a lower set of speed gears engage, giving higher power. When the road resistance lessens, the motor accelerates, and then increasing centrifugal force soon causes the next clutch to grip, and its gears run the car faster. Thus the car is sure to run automatically on the highest set of gears the conditions permit—i. e., with the highest possible road efficiency and without any effort by the driver. These clutches are so powerful that they can be depended on for sure grip, and the following functions are performed in an automobile with absolute certainty: (1) they grip and let go at just the right time; (2) they change gears automatically just when road resistance requires it, never too soon, never too late; (3) they change gears smoothly, it not being possible to break or damage gear teeth in changing; (4) they never permit the motor to be stalled, whatever the difficulties of the road or however carelessly the car is manipulated; for if the motor is slowed from any cause below 300 revolutions the clutches must let go and allow the motor to run free, without racing, for it is under the control of the governor; (5) they act upon all driving mechanism silently, for they engage gradually; (6) they give every range of car speed, from the lowest to the highest, and the car can be moved as slowly as the hands of a clock by throttling the motor and causing the clutches to slip a little; (7) they automatically compel the highest driving efficiency.

A Protection System for Superheaters.

IN Mr. Neilson's articles on superheated steam which have appeared in this issue and the preceding number of the Magazine, and especially in his discussion of the control of temperatures in the superheater (THE ENGINEERING MAGAZINE, March, 1905, page 964), he refers with commendation to the practice of mixing saturated and superheated steam together under certain conditions.

An important extension and a new application of this practice is found in the method of protection devised by the Potter Separator Company and embodied in the design of their superheaters. The saturated steam is applied not merely to the control of temperatures in the steam furnished to the engine, but to the protection of the superheater tubes against burning out or scaling while getting up steam. The



PROTECTION SYSTEM FOR STEAM SUPERHEATERS.

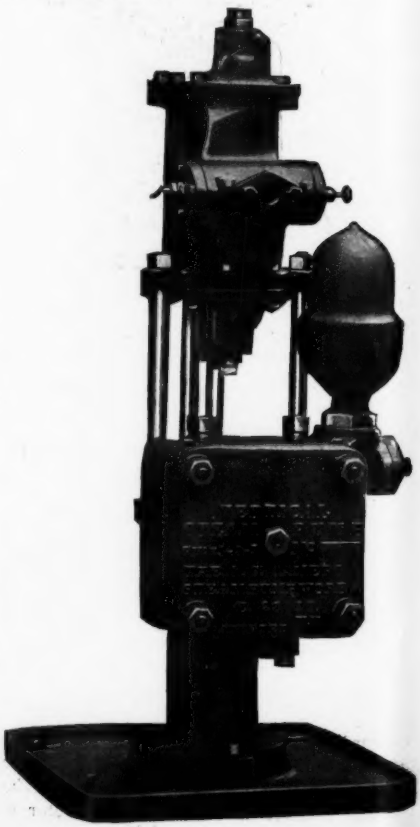
system is illustrated in the accompanying cut. The auxiliary saturated-steam main, as shown, connects all boilers at the superheater inlet, each connection being fitted with a valve. Thus any superheater may be supplied with saturated steam from the other boilers while the one to which it is attached is being brought into service. The saturated steam, passing through the superheater and into the superheated-steam main, keeps the internal conditions of the superheater normal at all times.

The Potter Separator Co., 39 Cortlandt street, New York, will furnish full details of the system upon request.

A Vertical Boiler Feed-Pump.

A VERTICAL boiler feed-pump made by the A. S. Cameron Steam Pump Works, New York, is shown in an illustration on this page. It possesses every attribute of a perfect direct-acting pump, occupies but little space and gives a maximum of capacity. Although shown on a base plate it is sometimes preferred, for marine use, to bolt the pump to the bulkhead by means of lugs cast on the back. This has been done with the pumps of this type furnished to the smaller gun-boats and which have seen quite active service in the United States Navy. In common with all Cameron pumps, no working part is exposed except a small part of the rod, which may also be covered, if necessary. The steam end may be adapted to work any steam pressure, no matter how high and the water end is fitted with Cameron priming valves, and a removable bushing or lining which may be taken out and replaced with a new one in a few minutes, thus avoiding any delay when it becomes necessary to renew the working barrel of the cylinder on account of wear.

A descriptive pamphlet of this and other pumps will be furnished on application to the manufacturers.



VERTICAL BOILER FEED PUMP.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Accumulators.

Catalogue illustrating and describing the unit accumulator. Contains tables of useful data. 6 by 9 in.; pp. 28. National Battery Co., Buffalo.

Air Compressors.

Leaflet, illustrating and describing the different types of air compressors manufactured by this company. 3 x 6 in.; 16 pp. Ingersoll-Sergeant Drill Co., New York.

"Compressed Facts About Compressed Air" is the title of a booklet giving a résumé of the points to be considered in buying an air compressor of medium capacity. Illustrations showing some type of compressor or part thereof adorn every page. 3½ x 6 in.; pp. 32. Clayton Air Compressor Works, New York.

Automatic Feed Pumps.

Bulletin B 81, describes and illustrates an automatic feed pump and receiver. This apparatus is arranged automatically to pump water of condensation directly back to the boilers without loss of heat. 6 x 9 in.; pp. 4. Geo. F. Blake Mfg. Co., New York.

Automatic Furnace.

Catalogue illustrating and describing the Model automatic smokeless furnace—an improved stoker furnace. Contains views of recent installations. 6 by 9 in.; pp. 30. Model Stoker Co., Dayton, Ohio.

Belt Conveyors.

Catalogue No. 5, illustrating and describing the Stephens-Adamson belt conveyor. Contains views of several recent installations, together with a list of users. 6 by 9 in.; pp. 78. Stephens-Adamson Mfg. Co., Aurora, Ill.

Cement-Making Machinery.

Catalogue No. 119 containing a description of rock breakers, crushers, dryers, kilns, ball mills, tube mills, elevators and conveyors. Finely illustrated and well printed. 8 x 10½ in.; pp. 44. Allis-Chalmers Co., Milwaukee.

Coal Handling Machinery.

Pamphlet entitled "United States Naval Coaling Stations," containing illustrations of the government coaling stations at the Boston, Portsmouth, New York, and Washington Navy Yards, with a description giving the size and capacity of each. 9 by 11 in.; pp. 16. Mead-Morrison Mfg. Co., Boston.

Coal Mining Machinery.

Catalogue No. 52, with illustrations, descriptions, prices and other valuable information of coal cutters, coal and rock drills, air compressors and equipment. 6 by 9 in.; pp. 134. Ingersoll-Sergeant Drill Co., New York.

Concrete Mixers.

Pamphlet illustrating and describing the American concrete mixer. Contains tables giving sizes, capacities and weights. 4 x 10 in.; pp. 16. International Fence & Fire Proofing Co., Columbus, O.

Concrete-Steel.

Pamphlet entitled "Modern Hydro-Electric Power Stations" briefly describing the merits of a type of open penstock construction particularly adapted to the modern power house and pulp mill. Contains illustrations of several recent installations. 9 x 12 in.; pp. 16. J. W. Rickey, 508 First street, So., Minneapolis.

Conveying Machinery.

Catalogue No. 7, containing half-tone illustrations and descriptions of elevating, conveying and power transmitting machinery for use in mines, iron and steel plants. Also contains tables giving dimensions, prices, etc. 6 by 9 in. pp. 208. Stephens-Adamson Mfg. Co., Aurora, Ill.

Drill Grinders.

Catalogue C containing descriptions and half-tone illustrations of drill grinders and their parts. 6 x 9 in.; pp. 22. The Washburn Shops, Worcester.

Dump Cars.

Catalogue treating of the different forms of dumping cars, suitable for railways, contractors, sand pits, and others engaged in the removal of large quantities of earth, rock, sand, gravel, etc. Illustrated. 6 by 9 in.; pp. 24. Continental Car Equipment Co., New York.

Dynamos and Motors.

Handsomely printed and finely illustrated pamphlet entitled "As the Photographer Saw Us," containing views of the supply and sales department, testing department, repair department, and a picture of the building itself. 7 by 11 in.; pp. 16. Guarantee Electric Co., Chicago.

Electric Equipment.

Bulletins Nos. 4398, 4399, 4400, 4401, and 4402, illustrating and describing respectively rheostats for railway generators and rotary converters; direct connected generating sets; subway transformers; motor starting rheostats with switches and fuses; and charging equipment for electric vehicles. 8 by 10 in. General Electric Co., Schenectady, N. Y.

Electric Pumps.

Catalogue, illustrating and describing the Aldrich electric pumps. Contains tables showing range of operation and capacity of the various sizes of pumps. 6 by 9 in.; pp. 48. Allentown Rolling Mills, Allentown, Pa.

Engines.

Catalogue No. 120, illustrating and describing the Reynolds Corliss engine and its details. Also contains tables showing sizes, etc. Allis-Chalmers Co., Milwaukee.

Filters.

Catalogue giving illustrations and description of the Greer filter for municipal, industrial and mechanical purposes. Contains views of several recent installations. 6 by 9 in.; pp. 48. Also, catalogue entitled 'Soft Water" treating of water softening plants. Illustrated. 6 by 9 in.; pp. 56. Greer Filter Co., Philadelphia.

Foundry Equipment.

Large, handsome and finely illustrated catalogue describing rolling mills, power shears, bending and straightening machines and tube mill machinery. Hydraulic machinery is also treated. 8 by 10 in.; pp. 172. Fischer Foundry and Machine Co., Pittsburg.

Laboratory Apparatus.

Catalogue illustrating and describing electrical experimental apparatus, high potential transformers, impedence coils, spark coils, permeameters and special apparatus and instruments. 5 by 8 in.; pp. 32. C. H. Thordarson, Chicago.

Magnetic Separators.

Catalogue illustrating and describing the Cleveland-Knowles electro magnetic separator. Contains tables showing the results of tests and several testimonials from users. 6 by 9 in.; pp. 18, United Iron Works, Springfield, Mo.

Milling Machines.

Catalogue composed of loose sheets printed on one side of the paper only and fastened together with a silk cord. One sheet is devoted to each different style of machine manufactured. It is finely printed and is illustrated with views of the miller and its parts. 9 by 11 in.; pp. 23. Kempsmith Mfg. Co., Milwaukee.

Catalogue No. 40, illustrating and describing a number of different designs of vertical milling machines, both belt and direct motor driven, especially adapted for locomotive and railroad machine shops. 6 by 9 in.; pp. 16. Newton Machine Tool Works, Philadelphia.

Mining Machinery Parts.

Catalogue treating of the manufacture of the wearing parts of all classes of mining machinery, roll shells, shoes and dies, locomotive tires and axles, high grade forgings and castings, and bar steel of every description. Illustrated. Contains valuable tables showing shrinkages, weights of tires, standard dimensions, (old and new style) and standard specifications. 6 by 9 in.; pp. 36. Midvale Steel Co., Philadelphia.

Motors.

Bulletin No. 1097, illustrates and describes the Westinghouse type K motors for direct-current series wound for crane, hoisting and similar service. 7 by 10 in.; pp. 32. Bulletin No. 1099 treats of Westinghouse bi-poplar motors —type R for direct current circuits. 7 by 10 in.; pp. 8. Westinghouse Elec. & Mfg. Co., Pittsburg.

Oil Burners.

Catalogue illustrating and describing the National oil burner. Contains tables showing the cost of oil as compared with other fuels. Steam traps are also given a place. 6 by 9 in.; pp. 24. National Equipment Co., St. Louis.

Ore Cars.

Catalogue No. 2, with half-tone illustrations on heavy paper and descriptions of the Traux automatic ore cars. Also contains tables giving sizes, weights, etc. 6 x 9 in.; pp. 28. Globe Iron Works, Stockton, Cal.

Portable Tools.

Catalogue illustrating and describing the full line of portable tools for railway repair shops manufactured by this company. 6 by 9 in.; pp. 36. H. B. Underwood & Co., Philadelphia.

Pumps.

Catalogue B, with illustrations and description of the De Laval centrifugal pumps, and diagrams giving the result of tests. 6 x 9 in.; pp. 48. De Laval Steam Turbine Co., New York.

Catalogue, illustrating and describing the various uses to which the Emerson double-cylinder steam pump can be applied. Also contains useful data and tables. 6 by 9 in.; pp. 38. Emerson Steam Pump Co., Alexandria, Va.

Rope Transmission.

A handsomely illustrated and cloth-bound book of 56 pages, entitled "The Blue Book of Rope Transmission." This book is the outgrowth of a leaflet entitled "Little Blue Book of Rope Transmission," containing much valuable information to anyone interested in the transmission of power. The "Blue Book" is a veritable storehouse of information, and will take its place as a standard authority on the subject it treats. American Manufacturing Company, New York.

Separators.

Catalogue, illustrating and describing the the Cochrane separators, oil and steam. Contains numerous testimonials and a partial list of users. Cochrane feed-water heaters are also treated. 6 by 8 in.; pp. 130. Harrison Safety Boiler Works, Philadelphia.

Thermit.

Pamphlet on the repairing of roll bosses by means of Thermit, the peculiar advantage of which lies in the fact that it can be ignited on the piece direct, the expense of a crucible being obviated. The testimonials at the back of the pamphlet indicate some of the works that have used this process, which is in general use in Europe. Goldschmidt Thermit Co., 43 Exchange place, New York.

Vitrified Brick.

Catalogue containing a brief description of vitrified brick for use in streets, sewers, foundations and buildings. Contains illustrations of several streets recently paved with this brick. 6 by 9 in.; pp. 24. Terre Haute Brick and Pipe Co., Terre Haute, Ind.

Wheel Barrows.

Pamphlet, describing briefly the different styles of wheel barrows manufactured by this company, with tables giving sizes and prices. Steel dump cars are also described. Fully illustrated. 6 by 9 in.; pp. 24. Archer Iron Works, Chicago.

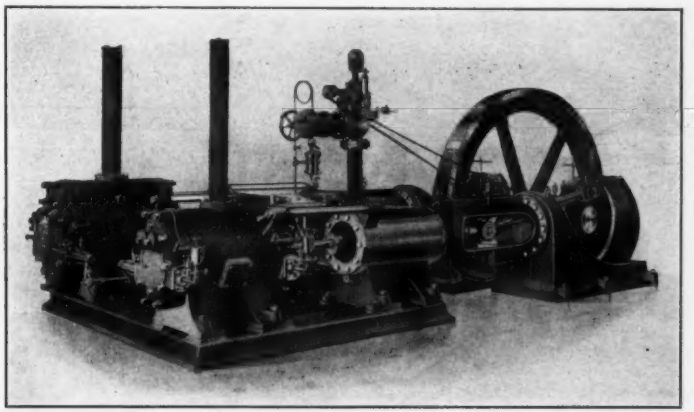
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A New Franklin Air Compressor.

THE accompanying illustration shows an air compressor recently furnished the Pennsylvania Railroad shops at Altoona, Pa. It is designed and built by the Chicago Pneumatic Tool Company at Franklin, Pa., and belongs to their C. S. C. class of machines, having compound steam cylinders and compound air cylinders. It is designed to run non-condensing with a boiler pressure of 100 pounds. The high and low pressure steam cylinders are 11 inches and 20 inches in diameter respectively, and air cylinders 11 inches and 18 inches with a stroke of 24 inches. Capacity of each compressor is 700 cubic feet of free air at 100 revolutions per minute.



A NEW FRANKLIN AIR COMPRESSOR.

All bearings are of unusually generous proportions to avoid any tendency to heating, and throughout are provided with removable shells or bronze bushings with simple, but effective, provision for taking up wear.

Steam cylinders are provided with Meyer adjustable cut-off valves. The main steam valves are double ported, admitting short ports and consequent reduction of clearance. The high and low pressure main steam valves are efficiently balanced, reducing friction and wear to a minimum.

Both air cylinders are provided with mechanically operated inlet Corliss valves, which are placed in cylinder heads admitting of close clearance and large port area, with consequent free admission of air. These valves are actuated by the steam cut-off eccentrics, so that four eccentrics drive both steam and air valves, the valve gear being very simple.

The discharge valves are of the poppet type, the valves proper being of cup shape, pressed from sheet steel. The valve seats and guides are removable and readily accessible for inspection or renewal. An intercooler, not shown in illustration, is provided between high and low pressure air cylinders, and cools the air after compression in the low pressure cylinder down to the temperature of the atmosphere. This intercooler can be placed where desired.

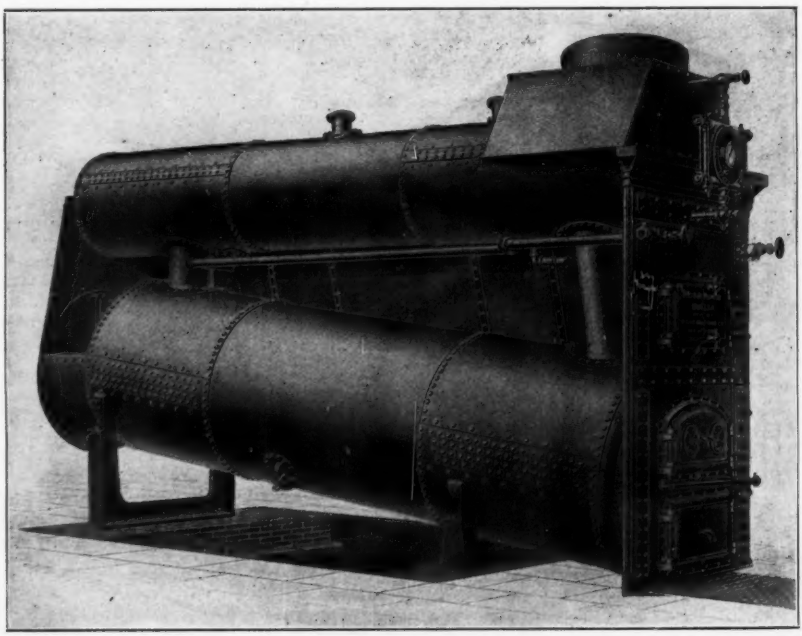
Owing to the small bore of the cylinders and proportionately long stroke, the percentage of clearance in air and steam cylinders is very small, resulting in high volumetric efficiency and economy of steam. The water jacketing also is much more efficient than in the compressors of ordinary proportions having diameters of cylinders about the same length of stroke. Provision is made for catching all drip from stuffing boxes and bearings.

The governor is furnished with a pressure regulator which brings the machine to a stop when the receiver pressure has reached a desired amount, starting it again automatically upon a slight drop in receiver pressure. The governor is also supplied with a safety stop which will prevent the compressor from running away in case of accident to the governor belt. A rigid box section sole plate extends under the four cylinders to which they are securely doweled, a feature which is of great help in setting the machine and maintaining its alignment.

Further information may be obtained from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, or 95 Liberty Street, New York.

The Robb-Mumford Boiler.

THE Robb-Mumford Boiler, which has been manufactured in Canada by the Robb Engineering Company for a number of years, and has recently been introduced in the United States in its latest improved form, is a combination of the principles of the English or Scotch internally fired boiler, with the inclined form and positive circulation of the American types of water tube boilers. The boiler consists of two cylindrical shells, the lower one containing a furnace of the marine corrugated type, with tubes extending from the fire box to the rear head. The upper shell forms the steam drum, the two drums being connected by circulating necks. The lower shell has an incline of about one inch per foot from the horizontal for the purpose of promoting circulation and draught. The gases, after



THE ROBB-MUMFORD BOILER.

leaving the furnace, which is surrounded entirely by water, pass through the tubes and return between the lower and upper shells, this space being enclosed by steel casing, asbestos lined, the smoke outlet being at the front of the boiler. The circulation of water and steam is towards the back of the lower shell and up the rear neck, where the steam is released in the upper drum, the water passing along the upper drum towards the front of the boiler and down the front neck, a semicircular baffle plate around the furnace causing the water to circulate to the lowest part of the shell under the furnace.

The principal points of advantage claimed for this boiler are: first, that the construction is entirely cylindrical, there being no flat surfaces requiring stays, except the tube sheets, which are stayed by the tubes; second, the water and steam spaces being divided between the two shells, the thickness of plate is not so great as in the Scotch marine or other forms of internally fired or externally fired shell boilers. Brickwork is entirely avoided, and there is no loss of heat by radiation or air leakage. The circulation of water is positive and perfect. Sediment or scale, when deposited, naturally falls at the front of the upper and lower drums, which form natural pockets where there is not much heat. The expanison and contraction of the plates of the boiler is practically equal in all parts, on account of perfect circulation and heat being applied both internally and externally. The Robb-Mumford boiler is also well adapted to marine work, the manufacturers having special designs for that purpose, which they expect to place on the market shortly. Full information will be furnished upon request to the Robb-Mumford Boiler Co., 170 Summer street, Boston.

Reinforced Concrete System.

THE illustration presented herewith shows the "Universal" bar, one of the latest forms of metallic bar for concrete reënforcement. There are several exclusive features about this bar that are well worth the attention of all interested in concrete steel or reënforced concrete construction. It will be observed that the cross section of this bar is originally the form of an oblong having its longer dimension four or more times that of the shorter, and has a series of recesses, or pockets, at intervals along its length, the width of the bar being increased at these points so as not only to maintain as nearly as possible a uniform cross section, but also to add to its gripping properties. Thus it will be soon that the bar does not depend upon the adhesion of the concrete for the transmission of the load, but the recesses or pockets receive the concrete in such a manner as to effectually prevent slipping. At the same time the tendency of the concrete to adhere to the steel is utilized to the fullest extent, since an oblong form of cross section will expose a greater amount of surface area than any other form of equal cross sectional area.

In developing this bar it was the aim of the manufacturers to do away with all beveled or tapered surfaces in the direction of the axis of the bar, consequently elimi-

UNIVERSAL REINFORCING BAR.

nating any wedge actions that would tend to separate the bar from the concrete when near the outer edge of girders, etc. To see that this has been accomplished one need only refer to the accompanying illustration.

Among the many other advantages to be found in this form of bar one of the most original and important is that it can be spliced readily by lapping the ends over several recesses, having male pieces or keys of elliptical form placed therein, and then clamping the whole together by means of square washers and small wedges driven between the inner side of the washer and the bar. In this manner connections can be made at any number of points along the bar. The advantage of this becomes more apparent when one considers what a large amount of metal is saved in steel plate girder construction by building up the cover plates at such points as require an excess of metal in place of making the chords heavy enough throughout to bear

the maximum strain. It is in this same manner that the universal bar can be utilized in concrete steel construction, owing to the possibility of connections at any point. This is especially important to those who are in favor of shear bars as they can be securely connected to the horizontal bars in such a manner as to make it impossible for the bars to slip, even were they perfectly smooth.

Other points in favor of this bar may be mentioned the ease with which it can be bent over an arch center or around corners; the increased efficiency and greater moment of resistence due to the greater distance the metal is kept from the neutral axis; the high elastic limit—50,000 to 60,000 pounds per square inch—when furnished in high carbon steel; and the long lengths in which this bar can be furnished.

The "Universal" bar is produced on a specially built mill, so arranged that all grades of steel can be produced, from the mild steel ordinarily used in structural work up to the high carbon steels bordering on tool steel. The majority of consumers, however, seem to prefer the high carbon steels, about 40 carbon, and it is in this material that the manufacturers carry most of their stock. The Rogers-Hall Company, Warren, Pa., are the manufacturers of the "Universal" bar, and shall be glad to send a special circular describing it, and dealing in detail with the peculiar advantages afforded by the unique connecting features. The Rogers-Hall Company are manufacturers and distributors only, and do not enter into contracting work. They confine themselves to the manufacture and production of the "Universal" bar, of which they will send samples on request

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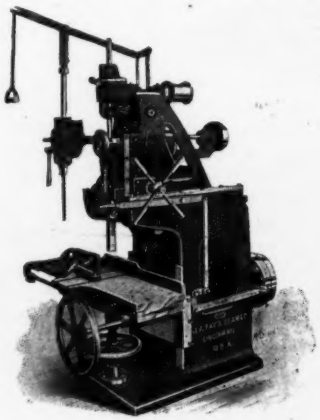
Car Shop Mortiser.

WE illustrate herewith a machine designed to meet the requirements of railroad and street railway car shops, agricultural implement, wagon and carriage shops and furniture factories, for a hollow chisel mortiser which is at once easy of adjustment and operation, strong and rigid, and free from complicated mechanism. It embodies new and important advantages, and is recommended where clean and accurate mortises are required. This mortiser is designed for chisels up to 1½ inch square. The main column is cast in one piece, with broad floor base, making it steady and free from vibration or jar. The upper part is carried on friction rollers, making it easy of adjustment for mortises out of line. The pilot wheel for moving the upper column travels back and forth with it, being always in convenient position for the operator. Stops are provided for the transverse movement of the upper column, the extent of which is 11 inches.

The chisel ram is mounted in a dovetail



CAR SHOP MORTISER.

slide and has a stroke of 6 inches. It is counterweighted, making it easy of adjustment, and can be quickly set to the different depths of mortise desired, or compensate for thickness of material. The boring spindle in the chisel is driven by miter gears, which permits of belting it from above or directly below the center of the machine. This cannot be accomplished on any other machine. The feed mechanism is contained in the lower column and gives two speeds to the chisel. This chisel has return stroke of "three to one," accomplished by means of elliptical gears. The feed is controlled by lever within convenient reach of the operator, and is so arranged as to stop the chisel instantly at any point of its stroke. The table is mounted on the lower column, forms a take up for all wear, and is 1 x 4 feet. It is raised and lowered 12 inches by means of screws and has a lateral movement of 18 inches by means of rack and pinions, together with stops for gauging

the length of mortise. It will accommodate material 17 inches high and 12 inches thick. An adjustable clamp is provided for holding any thickness of mortise, and goes clear to the fence. The auxiliary boring attachments are placed on one or each side of the frame at such a distance from the chisel as will permit of adjusting them to an angle of 30 degrees in either direction. These are convenient for joint-bolt boring, and save much handling of material. The depth of stroke of these boring attachments is 12 inches and the transverse movement 11 inches.

Further particulars will be furnished by J. A. Fay & Egan Co., No. 212 to No. 232 W. Front St., Cincinnati.

A River-Bed Power House

THE power house and pulp mill at Berlin, N. H., which is now nearing completion affords a very interesting example of concrete construction under great natural difficulties. The Androscoggin river is dotted for many miles with paper mills operated by water power. Not only does the river furnish the power, but it also brings the raw material to the mills. From the time the ice goes out in the spring until late in the summer the river is filled with spruce logs from the Maine and New Hampshire lumber camps which are floated down to the various mills to be ground into pulp. At Berlin there are two large paper mills less than one-half mile apart. Be-

A RIVER-BED POWER HOUSE.

tween them was the old pulp mill which the present structure displaces. This mill was on the right bank of the river and it took its power from a canal. Various additions to the capacity of the two mills rendered necessary a larger supply of pulp and the present mill was designed with twice the capacity of the old mill. It was apparent from the start that the problem of building this plant would be difficult and complex in the extreme. In order to utilize the available power to the fullest extent the novel and daring plan of putting the plant directly in the river bed was built over this canal. The permanent concrete across the river is about 15 ft. up river from the power house. The narrow space on the left between the power house and the snow-covered rock embankment is for the log channel, all logs for the plants further down the river passing through it around this plant. The second view shows the water rushing out the sluiceway into the river bed below the cofferdam across the south end of the power house site. Beside the rock taken out of the canal, some 20,000 yards had to be taken from the river bed itself to get a level foundation.

adopted. This necessitated the building of four distinct coffer-dams, the razing of the old mill and the widening and deepening of the canal, by the excavation of some 5,000 yards of rock. The International Paper Co. fully realized the magnitude of the task and they gave the contract to Frank B. Gilbreth on a cost-plus-a-fixed-sum basis.

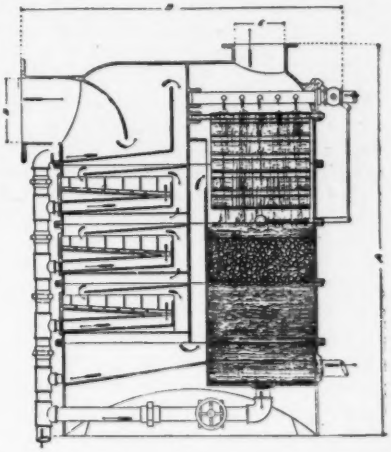
The first illustration shows the new power plant nearing completion. The foot bridge shown in the immediate foreground is over a coffer-dam which turns the water from the bed of the river into a sluiceway built through the enlarged canal. The gravity concrete mixer is on a platform

The water is admitted to the penstocks, of which there are four, from the canal on the right of the building. After passing through the wheels, it is carried off in draft tubes, which fall below the floor seven feet. These wheels are sixteen feet below the water level, and the main floor on which they rest is supported on concrete arches about twelve feet below the river bottom, the used water passing down the river between them. These penstocks each supply four Holyoke wheels, the wheels on three of the penstocks being direct-connected to pulp mills, one to each wheel. As the pulp is made it falls into a canal under the mills and empties into a pit, from

which it is pumped through pipes to the paper mills, one a thousand feet up and the other 700 feet down the river. The fourth penstock operates two wheels which are direct-connected to dynamos to furnish incidental power and light for the three plants. One of the remarkable features of this work is the fact that all the concrete was placed during the winter and the temperature averaged ten degrees below zero. In spite of this the most careful examination has failed to reveal any structural defect in the concrete and not a yard has had to be replaced. All the concrete used was mixed in the Gilbreth gravity mixer, the materials being measured automatically in a machine designed by Mr. Gilbreth for that purpose. Despite the exceedingly cold weather nothing but the water and sand were heated in mixing the concrete. The heat holding quality of concrete was manifested to a most interesting degree on this work. When the forms were removed from the concrete, often after a lapse of sixty days, it would be found that the whole mass would steam for a day or two, showing that the frost had absolutely failed to penetrate the concrete. No test of concrete could be more severe. The river at this season is somewhat high and as the final work is being done on the canal, no water is flowing through it, the only outlet for the water being the narrow log canal previously mentioned and the flood-gates in the main dam. These two gates, both of which have been open almost continuously for the past month, serve as an outlet for practically all the water in the Androscoggin River. It is an impressive sight to stand on the dam and see the two walls of water, each approximately ten feet square, rush through the dam and strike the wall of the power house above the arches with scarcely any perceptible drop, so great is the water's velocity. The conditions which necessitated this test are abnormal, because the main flood gates are in the dam at the south end of the canal and when the plant is completed this is the place where the overflow will be cared for. Not only this, but the river is unusually full of logs, and in order to keep them from going through the flood gates instead of through the canal, it was necessary to open the gates from the center instead of at the top of the dam. With ten or twelve feet of head it may be imagined what the impetus of this water means. On several occasions the flood gates have been shut for a few minutes so that an examination might be made, and as yet not a crack in the concrete has been discovered. Above part of the concrete building is a brick superstructure which serves as a machine shop. The concrete structure itself rises slightly above the main water level. It is interesting to note that the entire structure is without reinforcement, the strains being carried by the mass of concrete. Although no reinforcement is used in the concrete, the superstructure and roof are supported by a steel frame work.

Feed Water Heater and Oil Separator.

THE Loew feed water heater and oil separator, shown in the accompanying illustration, is intended to provide the modern steam plant with an appliance that thoroughly purifies exhaust steam, removing all the grease and oil; uses every available heat unit for heating the boiler feed water; and, in addition, filters the feed water and removes any precipitate that may be contained in it. It is claimed to



LOEW FEED WATER HEATER.

have the largest heating capacity per square foot of floor space and the largest filtering surface, thus filtering slowly. It also has the largest room for filtered water. The feed water is controlled by a specially designed balanced float valve built to operate against a maximum pressure of fifty pounds. The materials used in the heater are cast iron, copper and brass, thus offering the greatest resistance to corrosion and acids. Clean-outs are ample for easy and quick accessibility.

Over one per cent. of fuel is lost for every 10 degrees Fahrenheit that the temperature of feed water is delivered to the boilers under 212 degrees Fahrenheit, or under the temperature of exhaust steam. In the Loew Heater the temperature of the water is raised to 210-212 degrees.

In operation the steam passes through the oil separator; after being thoroughly purified, it ascends the channel on the side of the separator indicated by arrows in the drawing, and enters the open heater at the flange marked "C." Here part of the steam strikes the cold water; part of it enters tubes or gutters, where it is immediately condensed and passes down with the heated water to the filter bed. The steam which enters the tubes or gutters, after accomplishing its purposes of heating the feed water, passes out of the steam outlet without causing any back pressure. The dry steam can be used for any desired purpose about the plant. The water inlet is controlled by the float and balance valves shown. After the water is heated with the exhaust steam it passes through the large filter bed slowly into the storage chamber. From there it is pumped to the boiler.

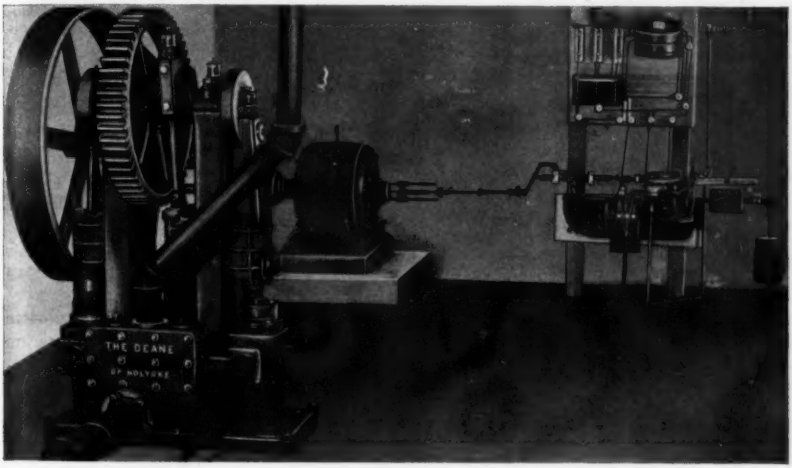
The heater and separator here referred to is known as the open type, but the manufacturers are making a closed heater for special requirements. They shall be glad to furnish full detailed description of either of these devices or other steam specialties made by them. Address the Loew Supply & Manufacturing Co., Cleveland, O.

Automatic Motor Starter for Electrically-Driven Pumps.

THERE was recently installed by the Deane Steam Pump Co. an electrically-driven triplex pump in connection with a hydraulic plunger elevator, in one of the large business buildings in Holyoke, Mass. The requirements in connection with the automatic operation of the pump and motor were of an unusual character, and a description of the means employed cannot fail to be of interest. The elevator is of the hydraulic type, in which the car is supported by a long plunger working in a cylinder to which water is admitted as desired from a closed tank. This tank is supplied with water by a 5 x 6 Deane vertical triplex single-acting power pump designed for a maximum water pressure of 150 lbs., and means are provided for automatically stopping and starting the pump to maintain a constant pressure in the tank between certain fixed limits. The pump is connected to a 15-horse-power General Electric induction motor operated by three-phase, 60-cycle, alternating current at 550 volts. The motor is of the General Electric type "L" having a variable starting resistance inside, which is thrown in and out by means of a sliding rod or shifter. The generator supplying the current to the motor is of such small size that it was feared that the fluctuations from the frequent starting and stopping of the motor would seriously affect the regulation of the potential of the distributing system and the above type of motor was selected as being best adapted for these conditions. In operating this motor the resistance is thrown in before starting, so that at starting all the resistance is included in the armature circuit. As the motor increases its speed, the resistance is gradually cut out by a movement of the sliding rod or shifter. In stopping the motor the current is first cut out by means of an oil-break switch and then the resistance is thrown in ready for the next start.

There was no device upon the market for operating this type of motor automatically, although numerous devices are in use for controlling the ordinary types of motor, having started boxes of the usual construction. A controlling device was therefore designed by the Deane Steam Pump Co. especially for this work, and the accompanying illustration shows this automatic controller arranged in combination with the motor and pump. A water pipe connects the elevator pressure tank with a Mason automatic belt shifter, consisting of a diaphragm chamber and a cylinder in

which a piston moves. The pressure of the water beneath the diaphragm is balanced by a heavy weight and any variation of this pressure causes the diaphragm to move a pilot valve admitting water to the cylinder for moving the piston. This belt-shifter is arranged in connection with a special device, so that when the pressure in the elevator tank falls below a certain point the upward movement of the piston in the cylinder will first close a switch admitting current to the motor and then throw the resistance rod to remove the resistance. As soon as the pressure in the tank has been raised to the desired point, the controlling device operates first to open the switch to stop the motor and then to throw in the resistance by pulling out the resistance rod or shifter. This is accomplished by mounting a set of cam pawls upon a slide connected with the piston of the shifted cylinder to form a ratchet which engages a cam lever connected with the switch break. The cams are so formed the switch lever is always thrown before the resistance is shifted, no matter in which direction the piston moves. The successful operation of this device in connection with this type of motor has solved a serious problem in elevator work where the current is used for both lighting and power service and the generator is of small size. The Deane Steam Pump Co. is prepared to supply this apparatus in connection with power pumps wherever the conditions render its use advisable. Practically the same arrangement of starting device has also been applied to the General Electric form "M" induction motor, having a special external resistance.



AUTOMATIC MOTOR STARTER.

Addition to the Caldwell Plant.

THE constantly increasing trade of H. W. Caldwell & Son Co., Chicago, has made it necessary for them to erect a new foundry building. In addition to their ordinary requirements in the way of castings, the Caldwell Company have, of late years, made a specialty of large pulleys, band wheels, fly wheels, and rope sheaves. They also acquired the entire line of gear patterns and power transmission machinery patterns of the Walker Company, of Cleveland, together with their gear-molding and gear-cutting machinery, and other appliances used by the Walker Company in connection with their gear business. It is their rapidly increasing trade in these lines that has made it necessary for the Caldwell Company to provide for very much larger foundry facilities, and with this end in view the new building has been erected. The build-

ing itself is 115 feet wide by 184 feet long. The main bay is 50 feet wide by 184 feet long, and the side bays are 32 feet wide. In addition to the main floor space, there is a gallery 32 ft. by 184 ft. on the east side of the building, while on the west side there is a charging floor, and a storage floor having a weight-sustaining capacity of 750 tons, this floor being the same in area as the east gallery. The side bays are served by small cranes, while in the middle or main aisle is a 20-ton electric traveling crane having an auxiliary hoist of 5 tons capacity. For the purpose of molding fly wheels and other castings of large diameter, there is provided a water-tight pit 10 feet deep and 50 feet diameter. The melting capacity is 30 tons per day, and the whole equipment is in proportion.

In making this addition to their plant, the H. W. Caldwell & Son Co. expect to be able to serve their trade with prompt deliveries, and also to be able to add to their line heavier and larger work than has heretofore been practicable. They expect to install shortly a Niles boring mill large enough to turn wheels 20-ft. in diameter and 8-ft. face. This, with their present complete equipment of machine tools of all sizes, will enable them to handle work of the most varied character, and of the largest and smallest dimensions.

Industrial Notes.

—The Allis-Chalmers Company decided on the 8th of April to begin immediately a three million dollar extension to their Milwaukee works for the manufacture of electrical machinery of all kinds of the largest types, and for the construction of steam turbines, hydraulic turbines and gas engines. Three large buildings will be erected and two of the existing buildings extended. The electrical department at Milwaukee will be operated in connection with the plant of the Bullock Electric Manufacturing Company, of Cincinnati, which is owned by the Allis-Chalmers Co. Also, the general offices are being removed from Chicago to Milwaukee, which will be made the center of the vast Allis-Chalmers system.

—The Boyd Equipment Co., 95 Liberty St., New York, has been organized by William A. Boyd for the purpose of carrying on a business similar to that conducted by the McLeod Co., manufacturers and contractors for high pressure piping. In addition to this, they will also take contracts for low pressure piping and every feature of mechanical equipment for buildings. Mr. Boyd was formerly secretary and manager of the McLeod Co.

—The general offices of the C & C Electric Company are located at Garwood, N. J., after May 1st, the office in Liberty street being closed, and a sales office opened at 149 Broadway.

—The C. H. Wheeler Condenser & Pump Co. has succeeded to the business of the Barr Pumping Engine Co. of Philadelphia. Clifton H. Wheeler, former president and general manager of the Wheeler Condenser & Engineering Co., is now identified solely with the C. H. Wheeler Condenser & Pump Co. The personal services of Mr. Wheeler, ample capital, modernly equipped works and an experienced engineering staff place the company in a position of unusual strength on condensers and pumps of every size and description. The new company will manufacture surface, jet and barometric condensers; vacuum and air circulating pumps—electric, geared or steam driven; water cooling towers; pumping engines and all auxiliaries for complete plants for both stationary and marine service, including highest vacuum guarantees for turbine requirements. The principal office is in Philadelphia, at Lehigh avenue and Eighteenth street, while a branch office has been opened in New York at 26 Cortlandt street.

—With the advent of the steam turbine speeds have increased so as to secure in generator construction minimum bulk and cost. A striking example of this may be seen in the power equipment of the Rapid Transit Company in New York. Turbine type generators with a rated output of 5,000 kilowatts, weighing 234,000 lbs., run at 750 rheostats per minute. Generators of the same output driven by reciprocating engines at a speed of 75 rheostats per minute, weight 980,000 lbs. Orders for eight turbine generators have been placed with the Westinghouse Electric & Manufacturing Company in the past few days, mostly for 400 and 500 kilowatt units, with one 2,000 kilowatt and one 2,500 kilowatt machines.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Accumulators.

Electric Storage Battery Co., Philadelphia.—Bulletin No. 88, treating of the installation of storage batteries for the Edison Electric Co., Los Angeles. 8 by 10½ in.; pp. 6.

Boilers.

Robb-Mumford Boiler Co., Inc., Boston.—Catalogue illustrating and describing the advantages of the Robb-Mumford internally fired boilers. Contains letters from users and tables giving dimensions, etc. 6 by 9 in.; pp. 40.

The Stirling Co., New York—In a tastefully produced catalogue entitled "Stirling—A Book on Steam for Engineers" much information of value is presented to the operating and consulting engineer relating to the economical generation of steam, and the result has been the development of some phases of the subject along entirely original lines. The chapters on superheated steam, fuel burning, utilization of waste heat, chimneys and draft, and analyses of flue gases contain much that is new in manner of presentation and of considerable interest. Well illustrated. 8 by 10 in.; pp. 248.

Bolt Cutters.

Reliance Machine & Tool Co., Cleveland.—Catalogue illustrating and describing Reliance bolt cutters. Contains tables giving sizes, prices, etc. 6 by 9 in.; pp. 56.

Building Construction.

Frank B. Gilbreth, Boston.—Pamphlet entitled "Rapid Construction, The Result of System," showing views of buildings in the course of erection and of finished buildings constructed under this system; giving the number of days required in each case to complete the work as far as shown in the illustration. Also contains numerous testimonials. 7 by 8 in.; pp. 16.

Centrifugal Pumps.

Morris Machine Works, Baldwinsville, N. Y.—Catalogue illustrating and describing the centrifugal pumping machinery, stationary and marine engines manufactured by them. Contains tables giving sizes, weights, prices, etc. 6 by 9 in.; pp. 90.

Condensers.

Deane Steam Pump Co., Holyoke, Mass.—Catalogue, No. D-23, reviewing the principles and advantages of the several types of condensers as applied to steam engines, including surface and jet condensers, and discusses, also, vacuum pumps, exhausters, air and circulating pumps, and other auxiliaries. Illustrated. 7¼ by 5½ in.; pp. 104.

Conveyors.

C. W. Hunt Co., West New Brighton, N. Y.—A comprehensive and well-illustrated catalogue of the Hunt noiseless conveyor, showing views of several recent installations. Other machinery for handling coal and ashes in power plants is also given a place. 6 by 9 in.; pp. 52.

Dumping Grates.

A. D. Granger Co., New York.—Bulletin No. 4 illustrating and describing the Vulcan shaking and dumping grates. Boiler fronts and other boiler castings are also illustrated and described. 6 by 9 in.; pp. 24.

Engines.

Watertown Engine Co., Watertown, N. Y.—Well printed and illustrated catalogue of single and compound engines. 7 by 9 in.; pp. 32.

Corliss Engine Works, Philadelphia.—Catalogue illustrating and describing the Rickards' Corliss steam engines. Contains numerous testimonials and a list of users. 6 by 9 in.; pp. 16.

Fans and Motors.

Robbins & Myers Co., Springfield, Ohio.—A handsomely illustrated and finely printed catalogue describing briefly some of the models of fans and motors which they are supplying to the trade. They have also published a "Motor Edition" which omits the fan motor section. 8x10 in.; pp. 60.

Feed-Water Heaters.

Warren Webster & Co., Camden, N. J.—Part II, General catalogue illustrating and describing the Webster feed-water heater and chemical purifier. 6 by 9 in.; pp. 40. Also a steam and oil separator price list.

Furnaces.

Murphy Iron Works, Detroit.—A well-printed and handsomely illustrated catalogue describing the special features of the Murphy automatic smokeless furnace. 6 by 9 in.; pp. 32.

Gasoline Engines.

Hart-Parr Co., Charles City, Iowa.—Catalogue illustrating and describing the constructive features and merits of the Hart-Parr traction and portable oil cooled gasoline engines. 6 by 9 in.; pp. 30.

Gears.

Boston Gear Works, Boston.—Illustrated catalogue "E" and price list of bevels, spurs, internals and racks especially adapted for high grade machinery. 5 by 8 in.; pp. 56. Supplementary catalogue "W" describing automobile gears and supplies. Illustrated. 5 by 8 in.; pp. 40.

General Railway Supply Co., Pittsburg.—A well-arranged and fully illustrated catalogue of cut or planed gearing from the smallest to thirty feet diameter for mine and industrial machinery of every description. Contains tables of useful gear data. 7 by 9 in.; pp. 128.

Generating Sets.

B. F. Sturtevant Co., Hyde Park, Mass.—Bulletin No. 63 illustrating and describing Sturtevant generating sets. Also contains tables giving valuable data. 6 by 9 in.; pp. 8.

High Vacuum Apparatus.

Alberger Condenser Co., New York.—Finely illustrated catalogue describing the Alberger dry vacuum pumps, condensers, cooling towers, and centrifugal pumps. 6 by 9 in.; pp. 28.

Locomotive Cranes.

Browning Engineering Co., Cleveland—Bulletins Nos. 10 to 14 illustrating and describing the various uses to which locomotive cranes manufactured by this company are adaptable. Bulletins Nos. 9 and 15 illustrating and describing automatic crab buckets and coil spring friction clutches respectively. 6 by 9 in.

Metal Lockers.

Merritt & Co., Philadelphia.—A series of four little pamphlets illustrating and describing the advantages of the expanded metal lockers.

Mixing Machinery.

Drake Standard Machine Works, Chicago.—Catalogue O devoted to machinery for continuous or batch mixing for concrete, asphalt and mortar. Contains views showing the mixer at work. Also, numerous testimonials from users in all parts of the United States. 6 by 9 in.; pp. 128.

Motor Cars.

The Adams Co., Dubuque, Iowa.—Catalogue entitled "A Study of the Adams-Farwell Motor Car" describing in very simple language, for the non-technical, the construction of their car. Fully illustrated. 6 by 9 in.; pp. 24.

Pattern Shop Equipment.

Fox Machine Co., Grand Rapids, Mich.—Illustrated catalogue and price list describing a full line of the tools especially adapted for both wood and metal pattern work. 6 by 9 in.; pp. 64.

Power Appliances.

R. R. Street & Co., Chicago.—Sectional catalogue, printed on loose sheets and bound together with fasteners, illustrating and describing the full line of power appliances manufactured by this company, together with tables giving sizes, prices, etc. 4 by 8 in.

Power Presses.

Consolidated Press & Tool Co., Chicago.—Illustrated bulletin No. 3, describing the full line of heavy power presses manufactured by this company. Also contains tables giving specifications. 6 by 9 in.; pp. 32.

Screw Plates.

E. F. Reece Co., Greenfield, Mass.—Illustrated circular entitled "Some Good Reasons Why," describing the Reece screw plates, dies which should interest every user of this class of tools. 6 by 9 in.; pp. 4.

Slag Ladles and Cars.

Wellman-Seaver-Morgan Co., Cleveland.—Well illustrated pamphlet descriptive of the principal features of the Dewhurst patent slag ladles and cars. 6 by 9 in.; pp. 14.

Steam Shovels.

Vulcan Iron Works, Toledo.—Artistic pamphlet illustrating and describing the heavy duty steam shovels manufactured by this company. 5x9 in.; pp. 12.

Steam Specialties.

Julian D'Este Co., Boston—Booklet illustrating and describing the full line of Curtis specialties manufactured by this company, including regulators, steam traps, separators, etc. Also contains tables giving dimensions, weights and prices. 3½ by 6 in.; pp. 32.

Steam Turbine.

General Electric Co., Schenectady.—Catalogue showing some representative installations of Curtis steam turbines which are briefly described in the titles. 8 by 10½ in.; pp. 26. Also a well printed and finely illustrated catalogue of similar size descriptive of motor generator sets, containing views of recent installations, together with a description giving the capacity of each. pp. 32.

Steel Piling.

Friestedt Interlocking Channel Bar Co., Chicago—Finely printed catalogue containing a brief description of the interlocking channel bar piling for deep excavations of all kinds. Illustrated with many views showing recent installations. Also contains numerous testimonials. 6 by 9 in.; pp. 64.

Telephones.

Edmonstone Co., New York.—Illustrated leaflet describing the Anders push button telephone; a telephone and electric push button in one. Contains a list showing the systems to which it is adaptable. 4 by 7 in.; pp. 16.

Vertical Filing.

Koller & Smith, New York—Pamphlet entitled "Vertical System of Filing" illustrating and describing the various methods of filing correspondence, specifications, contracts, shop orders, catalogues, etc., on the vertical principle.

Water Softening Apparatus.

Booth Water Softening Co., New York—Booklet presenting a concise description of the several types of machines built and a clear statement of the special advantages and uses of each. The construction and operation of important devices used in connection with the machines are also briefly described. Illustrated. 6 by 9 in.; pp. 24.

Water-Wheel Governor.

Lombard Governor Co., Ashland, Mass.—Bulletin No. 103, illustrating and describing Type N governor. 7 by 10 in.; pp. 8.

Wattmeters.

Fort Wayne Electric Works, Fort Wayne.—Pamphlet entitled "Notes on Induction Integrating Wattmeters and Their Uses" by A. A. Serva. A reprint of a paper read before the Colorado Electric Light, Power and Railway Association, September 21-23, 1904. Illustrated. 5x8 in.; pp. 24.

IMPROVED MACHINERY

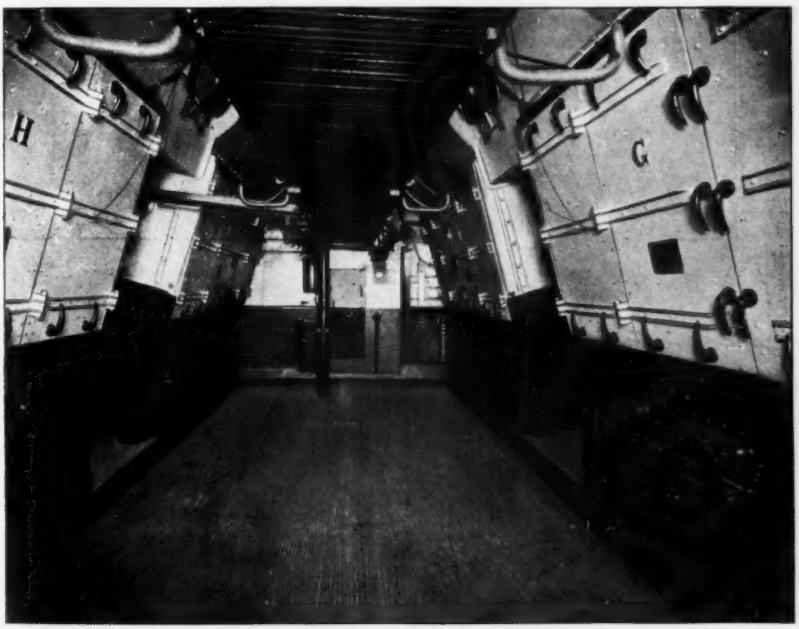
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

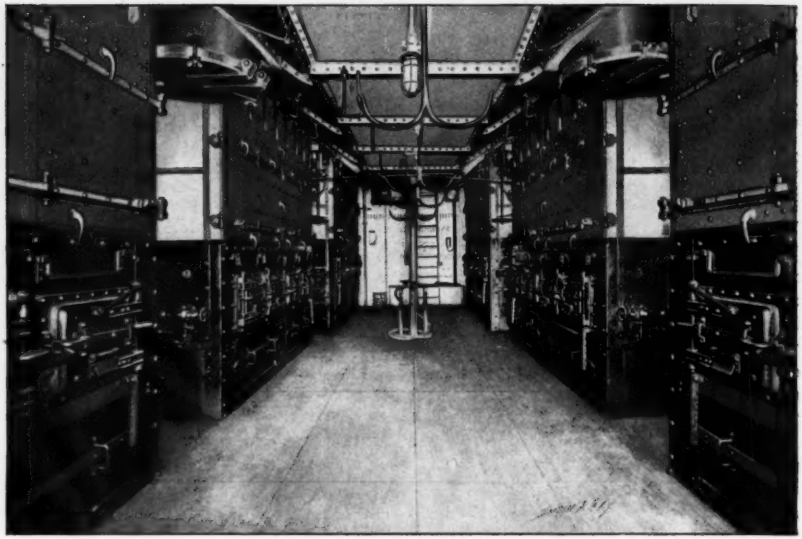
Modern Steamship Firerooms.

THE engraving published herewith represents the boiler room of the U. S. cruiser Chicago, and at once challenges the admiration of the beholder for its marked departure from the average boiler room of commerce. Here are no odds and ends or dunnage of any sort under foot or overhead; there are no bulging misshapen breechings projecting from the front, radiating heat and thick with dust which every gust that comes down the wind-sails scatters through the inferno of heat pervading the place. There are no nail-kegs, in unsuspected blind alleys, to catch the foot of the unwary groper in darkness and throw him on his beam ends; there are no dim, unreligious smoking torches and petticoat lamps to asphyxiate the heathen who wander in the nethermost hell in which they are compelled to earn a living; but in lieu of all these torments and miseries there is the exact opposite of them, and as they are shown in the engraving so they are in the ship. This is not a mere picture of a swept and garnished fireroom taken to impress the beholder for exhibition purposes, but is a record of the details of the vessel, and as such speaks for itself.

Now the function of a steam boiler is to make steam for all purposes, and since space is valuable on board ship, especially so in a national vessel, the problem presented to designers is a complex one.



BOILER ROOM U. S. S. CINCINNATI.



BOILER ROOM U. S. S. CHICAGO.

Steam in plenty beyond peradventure must be forthcoming, all the attachments and auxiliaries must be ready to hand and efficient; but, beside this, human beings should be able to live for long periods of time in comfort and security. Within the confines of a very few cubic feet there are several steam boilers carrying, in the case of the Chicago, a pressure of 250 pounds to the square inch, thousands of gallons of water heated to over 400 degrees Fahrenheit, and many tons of coal at a still higher temperature on the grates. These are housed in on all sides by iron walls, and any one of these boilers is big enough to heat the largest office building in New York City; nevertheless, so well are they isolated for one thing, and designed for another, that the heat is absorbed by the steam generating details and goes off into the funnel, robbed of all its ability to boil water. The temperatures of the spent gases are, with natural draft, seldom as high as 600 degrees and in most cases much lower. It will be noticed that the boiler fronts above the fire doors are painted white, and they stay white, in spite of the fact that the furnace gases of greater or less intensity of heat, according to the condition of the fire, are less than six inches from them. When under full steam these fronts are only hand-warm, or so that the hand can be held on them without discomfort. Corroboration of the assertions made is found in the economical performance of these boilers when in free route on sea service. The U. S. gunboat Marietta, 174 feet long by 34 feet beam, 1,000 tons displacement, has two Babcock & Wilcox boilers, weighing with all fittings and in steaming condition less than 60 tons (56 short tons). The Marietta made the run from San Francisco to Acapulco on 6½ tons of coal per day of 24 hours at a speed of 8½ knots, and this amount included galley fires and every other purpose for which coal is used aboard ship. She could run 7,500 miles upon her total coal supply. Her endurance under actual conditions of service is remarkable. She has been under steam for ninety days continuously, having in that time made 13,000 miles at an average speed of 9.2 knots, and this after having been one year in service. There is no need to add to this record, further than to say that it is not an exceptional one for the Babcock & Wilcox marine boilers, for a sister ship, the Annapolis, did just as well. As regards the temperature of the fireroom on

NEW UNION STATION AT HAMBURG, GERMANY.

ships having these boilers installed, the record shows that during a test on the Cincinnati's boilers not under actual conditions of a vessel in free route, but akin to it, the result was that in a closed building when the external air was 90 degrees Fahrenheit the boiler room showed only 94 degrees, with an average pressure of 205 pounds of steam, burning an average of 40 pounds of coal per square foot of grate surface.

Another most desirable feature of these boilers is the rapidity of getting them into service from water at the temperature of the external air, whatever that may be at the time. In the case of the Cincinnati's boiler steam was raised from cold water in 12 minutes, 40 seconds elapsed time, from starting fire, to 215 pounds gauge pressure. Comparing this with the performances of the old-fashioned Scotch boiler where it takes almost as many hours to get steam as it did minutes with the water-tube boiler, there does not seem any occasion for comment as to their relative values in this direction.

Within the limits of space available it is not possible to give more than a synopsis of the valuable features of these boilers, whether for marine or stationary work, for they are used wherever steam is required and are made for any pressures. One in Cornell University for experimental work carries 1,000 pounds per square inch gauge pressure. They are not for a day only, but for all time, and are the concrete result of years of study and service. The Babcock & Wilcox boiler of 1856 was a crude affair compared to its prototype of 1905, and the half century which has elapsed since the first conception struck Steven Wilcox has been spent in unceasing expenditure and experiment to attain perfection in all directions. If it is not the last word in steam generators it approximates that conclusion, for the aggregate horse power of these boilers afloat and ashore in daily use is enormous, taxing the ability of a modern shop with all facilities to keep pace with the demand.

Flat Glass on Curved Roofs.

HAMBURG, Germany, will soon enjoy the distinction of having the largest railway station in the world. The new station is a union depot, near the center of the city, convenient from both the business and residence sections, and will take the place of the half dozen stations of the dif-

ferent state roads leaving in as many directions.

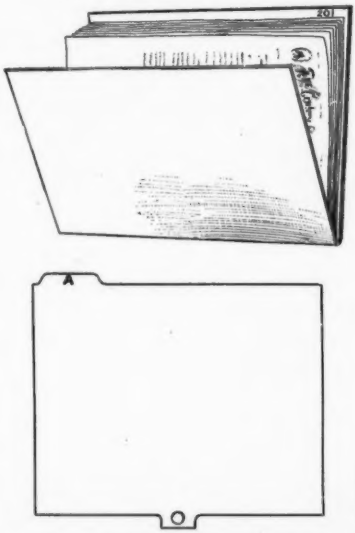
An interesting feature of this new station is the train shed entirely covered with glass. The form of the roof is curved, as will be seen by the illustration herewith; but, instead of using curved glass plates for the arches, the Anti-Pluvius system of flat plates has been adopted. The manner of fixing the flat plates and the prevention of the entrance of rain is shown clearly in the accompanying line drawing of a roof truss. The advantages of using flat glass plates instead of curved plates are, of course, many. In the first place, the bending of wire glass plates is very expensive, the cost frequently reaching four times the value of the glass itself. The curving of the steel supporting bars and all the connecting fixtures to conform exactly with the curved plates is both expensive and difficult, and the results are frequently unsatisfactory. As accidents to skylights are not infrequent, the use of flat plates is a great advantage, as they are to be had everywhere in stock, while curved plates are made only to order, and often require a month or more for delivery.

The American rights of the Anti-Pluvius system have been acquired by the American Machinery Company, 10 Battery Place, New York, who will be glad to furnish detailed information as to the application of this system of skylighting in manufacturing buildings, etc.

Vertical System of Filing.

THE accompanying illustration shows an office appliance which is gaining great favor among factory managers and superintendents. The vertical system of filing correspondence, shop orders, bills, sketches, blue-prints, etc., has unquestionable advantages over other arrangements. The principal of this is its elasticity in that it accommodates as many or as few papers under a given subject as may be required, so that they are immediately accessible for reference. The papers are always held in an upright position by means of an adjustable "follower-block" which is moved forward or back in the drawer as the quantity of papers increases or decreases. The drawers are supported on the sides by arms which slide back and forth with them, greatly reducing the friction and making them practically as easy to operate when filled as empty. These arms are so constructed as to allow of the drawer be-

ing withdrawn its entire length and held at right angles to the cabinet, making the entire depth of the drawer available for



FOLDER AND GUIDE FOR VERTICAL FILE.

filing and leaving both hands free to consult the papers.

The papers in the file are placed in folders shown in illustration, which have a

margin at the top on which may be written the name or subject covered by the papers it is to contain, and then folders are filed between stiff "guide" cards having tab projections at the top, on which is printed the letters of the alphabet or subdivision thereof, and where the numeric system of filing is used (assigning a number to a subject or name) the folders are numbered consecutively and the guides are numbered by tens, thus 10, 20, 30, etc.

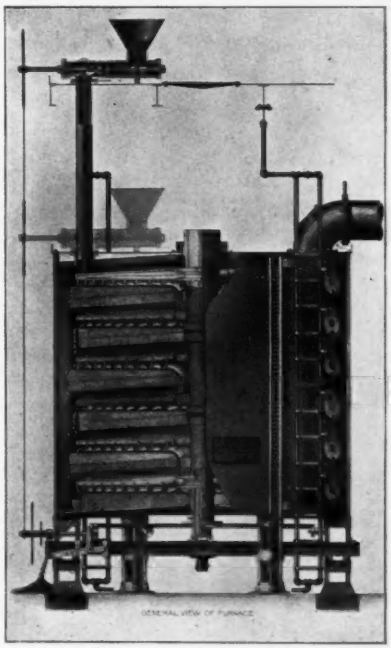
Fuller particulars of this and other office arrangements will be furnished by Koller & Smith, 141 Broadway, New York City.

The O'Brien Roasting Furnace.

THE illustration herewith shows a furnace worked out by A. P. O'Brien and installed at his works, Richmond (Va.) Guano Co. about four years ago. Within the past year the American Coke and Gas Construction Co., Camden, N. J., secured the rights to its manufacture, and have perfected it mechanically. A number of installations have been made, and the results will be interesting to managers and superintendents of metallurgical, chemical and fertilizer works.

The furnace consists of an iron shell enclosing and supporting brick shelves and lining. This shell is supported by channel and I-beam posts resting on a circular foundation wall. Two of these posts are connected by horizontal I-beams, upon which in the center is a ball-thrust-bearing which supports the tapering, tubular air cooled shaft. The I-beam supporting the shaft rest on set screws which provide for the adjustment and alignment of the shaft. This shaft may be removed while the furnace is under fire, and a new shaft may be used or the old one repaired without letting the fire go out. The air cooled rakes are inserted in removable sockets in the shaft and cannot rise or turn; they keep a true and even bed on each shelf, being locked in place by means of a slot and key; they may readily be removed or replaced. The teeth of the rakes are in proportion to move the ore at a uniform speed from the center to the circumference of the shelves and vice versa. The furnace is provided with ore feed hopper and a mechanically driven screw feed; in the brick shelves are provided a sufficient number or openings for the dropping of the ore from the upper to the lower shelves; tubular outlets discharge the cinder from the bottom of the furnace; these latter are fitted with closing slides so that the air drawn into the furnace may be regulated to afford proper combustion; a further regulation of air is afforded by adjusting slides in the doors opening to each shelf.

The furnace is provided with two sets of doors opening into each compartment; one set is placed diametrically opposite the other so that repairs may be made easily.



GENERAL VIEW OF FURNACE.

An iron ladder designed for water cooling, if desired, is supported by the shell and runs alongside each set of doors and the doors are made to lock when shut or opened so that the examination and working of the furnace is extremely simple. The furnace shaft and rakes are driven by pinion and rack; the meshing of the rack and pinion teeth is so governed that any possible obstruction within the furnace will cause the teeth of the rack to jump up out of mesh and the loud clicking noise will attract the operator's attention, who may immediately stop the furnace by the throw of a lever and so prevent damage. The

alternate brick shelves are provided with luting rings and the shaft with lute covers which prevent the escape of gas through any but the desired openings; this is also true of the furnace top plate. An elbow, provided with clean-out an shut-off damper, serves as a gas off-take; both the gas off-take and ore feed are set to the furnace with gas tight connections.

The furnace is mechanically driven and any number of them may be run in series; and any one or more so run may be independently cut out by the throwing of a lever to a position which raises the rack teeth out of mesh with the pinion; this is readily done, owing to the flexibility of the rack plate. The power required for the mechanical operations of one furnace equals approximately one-eighth of a horse power.

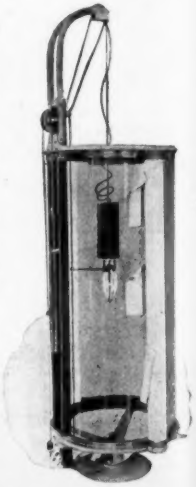
A few of the distinct advantages of this furnace are: the arms are put in and taken out horizontally and without raising, consequently the shelves are closer together and the radiant heat is better utilized, securing a more complete roast and greater efficiency. For the same reason, there is room for an additional shelf without increasing the height of the furnace. For the above reasons the capacity of this furnace is increased at least twenty per cent. over any other of the safe size. Less power is required than for any other furnace of equal capacity. The feed is automatic, positive and easily regulated from the floor and is equally efficient for all grades of ore. This feed will work so accurately that the operator will know exactly the amount of ore being fed. Repairs are much less than on any similar type of furnace. The rabble arms, which are the wearing part, are shorter and lighter than in any other furnace; owing to this and their air cooling system they last longer and cost less to replace. The air cooling system is positive. Cool air enters at the bottom of the tapering tubular cast iron shaft and must pass through every division of the shaft and rabble arms before it escapes from the shaft top. No stack is required, nor other artificial means of creating a draft through the central shaft. The central shaft can be withdrawn and replaced in a short time without cooling or tearing apart the furnace. The driving mechanism is light, simple and near the periphery of the furnace, where it can be easily reached for oiling and repair instead of being, as usual, at the center of the furnace where it is almost inaccessible.

Further particulars regarding these furnaces may be obtained by addressing the American Coke and Gas Construction Company, 17 Battery place, New York City, or their offices at Camden, N. J.

Blue Printing Machine.

THE accompanying illustration shows the Wagenhorst electric blue printer. It consists of a glass cylinder with an arc lamp arranged to descend axially through the cylinder, thereby giving equal light radiation to the interior surface of the cylinder, and hence a uniform development of the blue print paper. The electric current is automatically shut off, the descent of the lamp is automatically stopped, and the entire machine is automatically shut down at any predetermined position of the lamp. This prevents over-exposure of the prints, economizes on current, and permits the operator to carry on other work, or even to leave the room without in any way endangering the mechanism or the prints. The switch automatically indicates by sound when the printing process is completed.

The roller curtain device, by which the tracings and sensitized paper are held in place, is most efficient, convenient and accessible. It stands still, except when pushed along by the hand. Or it may be pushed by the knee, thus leaving both hands free to adjust the tracings and paper. This device is particularly convenient for making a number of small prints. The illustration shows us the cylinder partly filled. The roller curtain holds the tracings and paper so securely against the glass that at any time the rollers can be partly rolled back, permitting an examination of the prints without in any way dis-

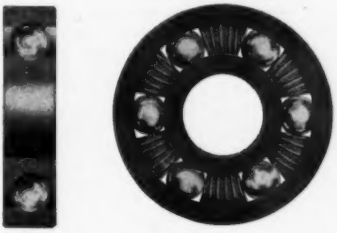


turbing the position of the tracings with respect to the prints, on the same principle as the old sun frames. This provision is only necessary, however, when using tracings of mixed transparency—old and soiled tracings requiring longer exposures than new ones.

A hydraulic speed regulator is provided, which secures an absolutely uniform speed at all times. It also provides a wide range of speed regulation, so that the machine may be adjusted to meet all possible requirements, ranging from an exposure of five seconds to several hours. By means of a valve regulator, the speed can be varied either before or after turning on the current. The machine is noiseless in operation. The manufacturers, J. H. Wagenhorst & Co., Youngstown, Ohio, will furnish further views and particulars upon request.

Ball Bearings for Machinery.

THE ball bearing may be said to have contributed more than any other cause to the success of the bicycle. This success stimulated the employment of ball bearings to engineering constructions, but the employment of types that had been successful under such light loads gave such poor results as to bring the entire idea into general disrepute. This was due, however, merely to the failure to recognize the principles of correct construction, involving



not only the shape and proportion of the various parts, but also the selection of proper materials, the recognition of the need for a high degree of workmanship and very careful heat treatment of the materials. It has since been demonstrated that the highest carrying capacity and greatest resistance to wear was realized in a bearing in which the balls made contact at two of their opposite points, and in which the ball tracks had a cross section closely approaching to, but larger than, the curvature of the balls. Experiments have proved the necessity for the greatest degree of precision, and a high finish of balls and races and painstaking uniformity in the composition and treatment of the steel. The latest development along these cardinal lines is illustrated herewith in elevation and cross section. This bearing is simplicity itself, consisting merely of an outer race, an inner race, and a series of balls and elastic separators. These separators

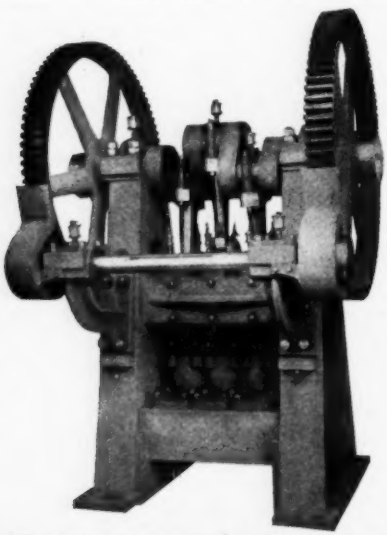
constitute the latest improvement, permitting the use of these bearings, known as the Hess-Bright, for practically any loads and any speeds from a few pounds to many tons and from a few turns to seven thousand or more revolutions per minute, while being independent of shaft flexures far exceeding those that the shafts themselves or other mechanisms mounted on the shafts would permit. The years of experimental work connected with the development of these bearings proved conclusively that it was necessary for long continued satisfactory results that a bearing should show not enough wear in the lifetime of a machine to require adjustment of any kind. Proportioning the bearings with that fact in view naturally resulted in the elimination of all adjusting devices, with the advantage of making the bearings entirely independent of the skill or ignorance of the machine attendant. Exhaustive experiments have shown that the co-efficient of friction at the shaft is .0012 of ⅛ of one per cent. of the full load, and further than that the starting friction is no greater than the running friction. Employed in line and countershafting these bearings have prac-

tically eliminated all friction load but that of the engine itself. Such authorities as Webber for textile plants and Benjamin for machine and metal working industries have found the average friction loads of ordinary bearing, exclusive of the engine, to vary from 20 per cent. to 70 per cent. of the total developed power.

An illustration herewith shows an Electro-Dynamic Company's interpole motor with the armature mounted on ball bearings. Mr. Henry Hess, of the Hess-Bright Co., 245-247 No. Broad Street, Philadelphia, has gathered a great quantity of data relating to experiments with ball bearings applied to machinery and the saving effected through their use, and would be glad to hear from those who are interested in machine design and construction.

High and Low Pressure Pumps.

WE illustrate herewith an Allegheny high and low pressure pump. This series of pumps has great rigidity and strength, accomplished by making every part sufficiently heavy to insure its doing its work with great ease, and by so combining the parts that there can be no side strain or working loose of any of them.



All valves and passages have been made so large that under any speed the plungers have all the liquid they can possibly handle. This feature alone is especially appreciated by those who have used pumps not capable of handling their claimed capacity. Convenience of the operator has been kept in mind in designing the Allegheny pump, and every valve is immediately accessible. Depressed packing flanges reduce the frequency of packing to a minimum and it is impossible for any valve to get out of place. They are adapted for use in mine or factory, or wherever else a high or low pressure pump is needed. The makers are the Allegheny Foundry Company, Limited, Warren, Pa., who will be glad to furnish interesting details of construction and performance to those who make inquiry.

Reflex Water Gauge.

THE distinguishing feature of the Reflex water gauge shown in the accompanying engraving is that the water appears black while the steam shines as if silver. The principle of the Reflex glass is based upon the optical law of the total reflection of light when passing from a medium of greater refractive power into a medium of less refractive power. By cutting grooved facets at proper angles in the inner surface of the glass, it is possible to eliminate all light from the vacant space back of the glass and at the same time permit the passage of light through that portion of the grooves covered with water or other liquid. Thus a sharp, clear line marks the height of water or other liquid, above which the air or steam space has a bright, mirror-like appearance, while

the liquid takes the color of the background in the chamber, and as black is usually selected for the sake of greater contrast, the water shows black.

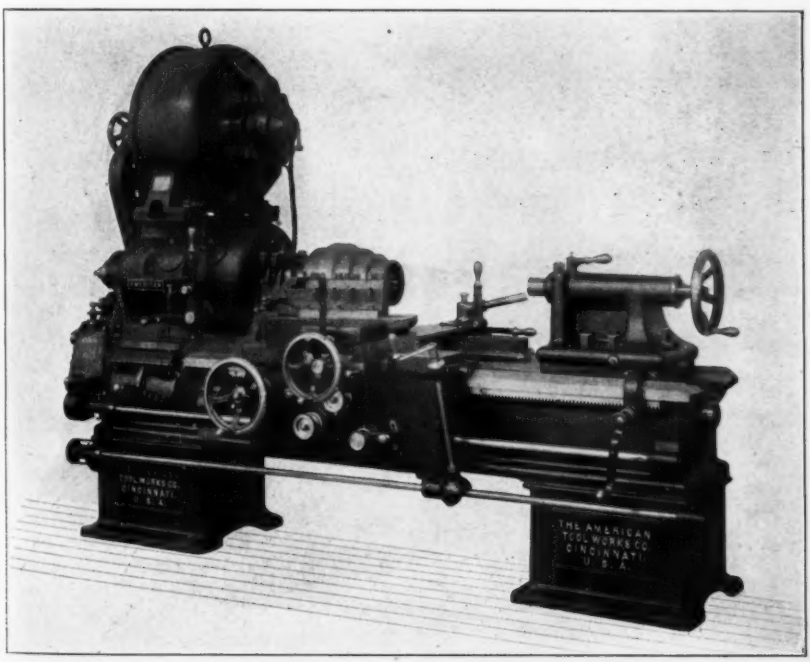
Various applications of the Reflex principle can be utilized in the construction of gauges for indicating water levels, etc. For instance, in vacuum pans for boiling sugar, glue, etc., where it is essential that the color and consistency of the liquid be observed from time to time, a gauge with hinged or removable background may be employed. Instead of using a single glass background, a pair of Reflex Glasses may be arranged, one each at front and rear of a column of water and steam. If a gauge of this kind be lighted from behind, the part containing water will show bright, the water permitting the passage of the light, while from the steam space it will be reflected.

The Wm. T. Bonner Co., 246 Summer Street, Boston, are the makers of the Reflex gauge, and will send a catalogue of this very interesting instrument to those who request it.

Motor Driven Lathe.

THE illustration on this page shows a 24" by 8' "American" lathe with motor drive through the American Tool Works Company's special all-geared head, also equipped with multiple tool rest used with rapid turning of cone pulleys. The motor is 9 horse power, of the direct-current, variable-speed type, 600 to 1,200 revolutions per minute, and is easily started, stopped and reversed by the controller handle placed at the right end of the carriage. The large number of speeds obtained electrically supplement the regular speed changes obtained mechanically through the all-geared head. This all-geared lathe head provides four spindle speeds from 32.5 to 1 to 1.44 to 1.

Because of the high geared ratio and the wide face driving pulley, the power of this device is evident, the lathe taking, without distress, continuous cuts entirely beyond the pulling power of an ordinary lathe of much greater swing. Each mechanical speed is obtained instantly and easily while the machine is in operation, through the



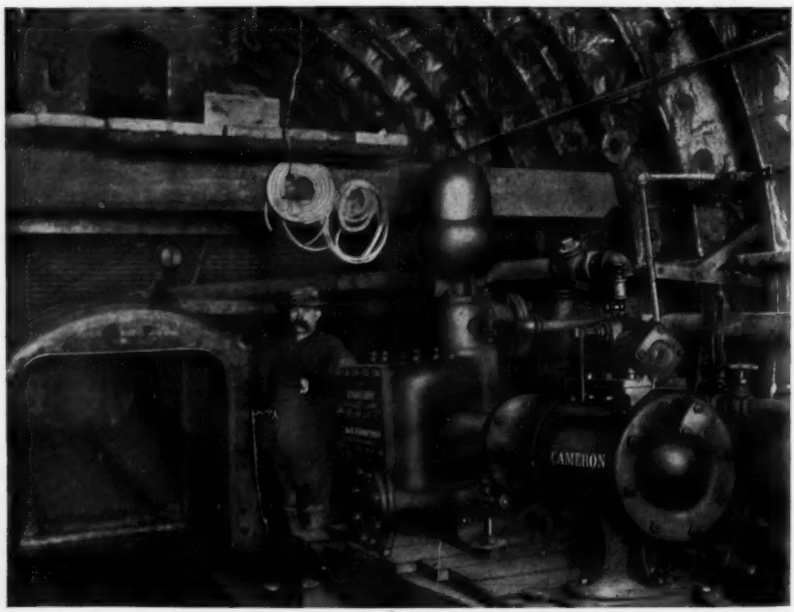
manipulation of the two levers shown on the front of the head which, in turn, operate powerful clutches. The construction is extremely simple and efficient, since only six gears are required. They are coarse-pitch, wide-face and cut from a solid, and being arranged to run at very low-pitch line velocities, reduce to a minimum the noise incident to all gear drives. There are no slip gears, pull pins, hollow shafts, tumbler gears or frail parts of any kind.

In addition to the all-geared speed change device, this lathe is equipped with a rapid change gear mechanism providing a wide range of changes for feeding and screw cutting, each change being instantly obtainable while the machine is in full operation without the removal of a single gear. Although intended to be motor driven the lathe may be rearranged for belt drive by simply replacing the gear on the driving shaft with whatever size pulley is required. As it is unnecessary to shift the belt to change the speed, a pulley of very wide face and large diameter may be used. Full particulars of this interesting tool will be furnished by the American Tool Works Company, Cincinnati, Ohio.

Pumps in the East River Tunnel.

THE expenditure of millions of dollars in New York in subways and tunnel work is attracting considerable attention, owing to the difficult engineering problems encountered and subsurface tunneling methods employed by the various contracting firms who are executing the work. The accompanying illustration shows a photographic view of the Brooklyn and Manhattan tunnel pumping station, situated in the tunnel on the Brooklyn side of the East River. This tunnel is now in the course of construction under the East River, and will connect the Brooklyn subway with the Interborough subway at the southern end of Manhattan Island. The overhead construction of the tunnel is clearly shown with the sectional cast iron lining.

Soon after ground was broken for the tunnel, it was necessary to install a pumping plant to provide for the removal of the water, and the illustration shows a Cameron regular pattern piston station pump, 14" x 10½" x 18", of the light service type, in position in the tunnel, about 100 feet from the Brooklyn shaft. The reader will notice a bulkhead, consisting of a solid brick wall built across the entire tunnel.



This wall is three feet thick, heavily braced with timbers, and forms the compressed-air chamber situated on the further side of the bulkhead, where the air pressure is maintained at 20 pounds per square inch. The tunnel is being driven by the "pneumatic shield" method. The entrance into the workings of the tunnel is through the two air locks, which are also shown in the view. The lower air lock, which is 6′ 6″ in diameter, is used for the removal of material by cars. The upper air lock is an emergency lock for use by the men in escaping in case of the flooding of the tunnel.

The accumulation of water in the excavation is forced out of the air chamber by means of the air pressure through a pipe built within the bulkhead, the water falling to a sump outside of the wall, from which it is pumped to the surface, the lift being 60 feet. Owing to the water being very dirty and gritty, the water cylinder of this pump is supplied with a removable iron bushing. The pump is operated by compressed air, the exhaust of which is delivered into the compressed air chamber of the tunnel, where it is again utilized. The Cameron pumps are especially adapted for this work, being compact and strongly built, having few working parts, and no outside valve gear or rods to become broken or to get out of alignment. The construction of their operative mechanism is such as to give equal efficiency with compressed air or with steam, and are the product of the A. S. Cameron Steam Pump Works, having their general offices and works at the foot of East 23rd Street, New York.

A New Explorers' Transit.

QUEEN & CO., Philadelphia, have just brought out a new explorers' transit, especially adapted for preliminary surveying in connection with locating railroads and mining operations. The size and weight have been reduced, while retaining all the advantages of the "Queen City" and "Bridge" transit. It measures 8 inches over all. The outer diameter of the horizontal limb is four and one-quarter inches and the transit and tripod complete weigh eleven pounds. The achromatic telescope is six and a half inches long and has power of eighteen diameters. It is fitted with dust cover to draw tube. Fixed stadia wires; ground and graduated level, mounted under telescope; two and three-quarter inch vertical circle, graduated to half degrees on solid silver, and reading by vernier to single minutes; horizontal circle three and

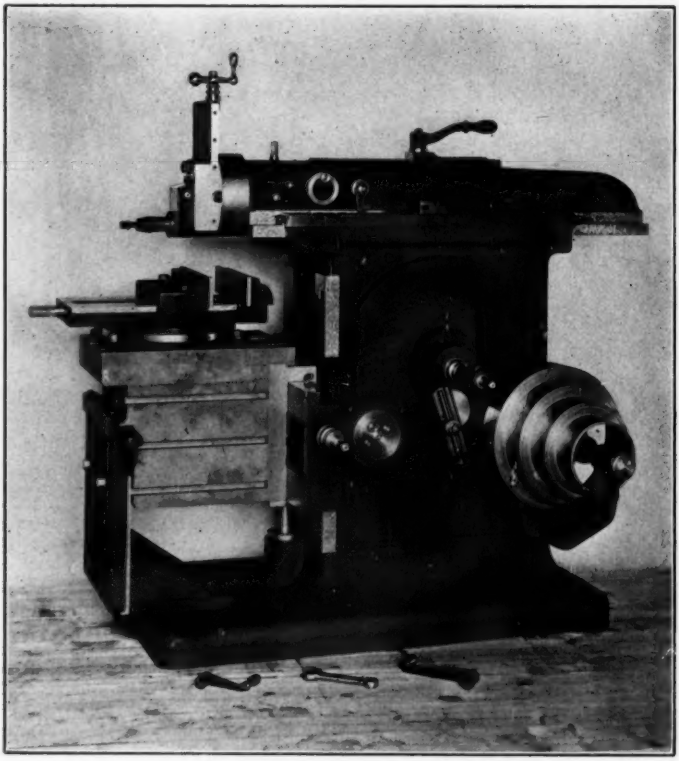
a half inches diameter, graduated to half degrees on solid silver, reading by double verniers to single minutes. The graduations on the circle are figured in two rows, from 0 to 360° in opposite directions. The shifting plate tripod head makes it possible at all times to center over plumb bob. The manufacturers will furnish fully descriptive circular upon request.

Stockbridge Shaper.

AMONG interesting features of a new design 20″ shaper made by the Stockbridge Machine Company, Worcester, Mass., the following are worthy of special note.

It possesses automatic feeds to both head and table, adjustable while the machine is in motion. The table is supported the entire width when in any position on the bar and is raised sufficiently above the saddle to allow T bolts to be put in from the back as well as from the front. The table hooks over the saddle, thus giving greater rigidity to it than when bolts alone are used. All backings are tapered. The driving gear is 20″ in diameter with a 3½″ face. This, together with back gears and the four step cone to carry a three-inch

belt, would make this a very desirable machine, but, beside this, in common with all shapers made by the same house, it is equipped with the Stockbridge two-piece crank motion, which gives a powerful and even-cutting speed the entire length of the cut together with a quick return. The gear and crank are so constructed that it has the same rigidity on a long stroke as on a short one, insuring a cut as free from shatter on a twenty-inch as on a five-inch stroke.



The intention of the designers of the shaper shown herewith is to make it the most powerful shaper of its stroke on the market. In doing so, they have not overlooked the fact that it should have the necessary rigidity to withstand the peculiar and excessive strains to which it is subjected. Neither have they overlooked accuracy in the system of jigs and the various tests to which the parts are subjected, insuring as perfect a tool as can be made at the present time. The column is of unusual width and depth, is ribbed and braced internally, and of a form to resist to the highest degree the peculiar strains to which it is subjected, while the horns projecting at the front and back give an unusually long bearing to the ram. The rail is deep, ribbed horizontally and strongly gibbed to the column, and the cross traverse screw is provided with a graduated collar reading to .001 of an inch. It is also provided with a variable automatic speed, changeable from nothing to full feed while the machine is in motion.

The machine shown herewith is now on exhibition at the Liege Exposition, Belgium, but the motor attached to it there is different from that shown in the photograph. The motor shown is of American make, and for this reason does not fit the motor pad prepared for the European make of motor. The shaper was made by the Cincinnati Shaper Co., Cincinnati, Ohio.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Drainage of Tunnel Under the Harlem River.

PROBABLY one of the most important engineering problems encountered in the building of the New York subway was the construction of the two tunnels or tubes under the Harlem river. These two tubes were constructed on an entirely new engineering principle, having been built of concrete above the ground, and then sunk to the bottom of the river. These twin tubes are 641 feet in length and 16 feet in diameter, the top of the tunnel being 20 feet below low water. Before the tubes were put in place the engineering department of the subway contractors devised a system for the drainage of the water percolating through the walls of the tubes, and also in case of emergency arising from the sudden inrush of water in the event of the breaking of a water main. The drainage and pumping system adopted, and the precautions taken to meet the possible conditions, are graphically described and explained in the accompanying illustration.

Special pumps were designed and built for this service by the A. S. Cameron Steam Pump Works, foot of East 23rd street, New York.

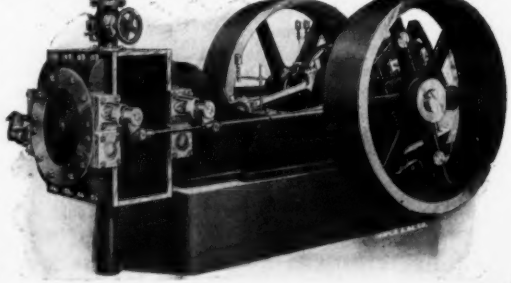
The accompanying view shows two of the pumps in position on concrete foundations, with the arrangement of piping and connections. Four of these pumps were installed, being of the size 12 x 12 x 18, and are of the simplex single cylinder pattern, having the Cameron regular pattern steam end, which is equally efficient with compressed air or with steam. The motive power for these pumps is compressed air. Each of the pumps has separate air lines

to the compressor plant, situated over three-quarters of a mile away. The pumps are controlled automatically by separate floats located in the tunnel. The automatic float for one of the pumps is shown in the illustration along the wall on the left hand side. The other pump, in the distance, has its automatic float nearer the floor and attached to the pump. An air reservoir 16" in diameter by 36" long is arranged in the air pipe line at the throttle of each pump. The suction piping is also shown extending into the sump, the top of which is protected by iron gratings.

A distinctive feature is the construction of the water cylinders, which necessarily are very compact, owing to the limited space allotted to them, the extreme width being only 19". They have nevertheless ample water valve area. The water valves are set in removable valve decks, allowing them to be easily removed with minimum time cost. The suction valves are placed under the water cylinder, and the discharge valves are shown above the water cylinder.

The pumps are separately and independently connected and are also designed with the suction and delivery flanges looking fore and aft, permitting the arrangement of the suction pipes as shown, with the pipes running under the "air end," and the foot under the air end made in two parts, straddling the 6" suction pipe, permitting the piping to be readily removed.

Each pump is capable of delivering 600 gallons of water per minute while running at normal speed, with an air pressure at the throttle of about 70 pounds per square inch, and a total lift of 70 feet. The capacity could be increased to 1,000 gallons per minute in case of emergency. The valve chambers are so constructed as to permit of easy access for inspection and necessary repairs. The water piston and rods are of composition, and owing to the liability of the water's being dirty and very gritty, the water cylinders are constructed with removable composition metal bushings. The suction pipes of the pumps are supplied with Cameron strainers of the gooseneck pattern to keep out the dirt and rubbish and to insure the priming of the pumps by keeping the suction chambers filled with water; thus the cylinders will be flooded with water at all times, permitting the pumps to be started up at any time by the automatic floats. In the event of the water's rising, each of the pumps would immediately start pumping as soon as the water reached the float level.

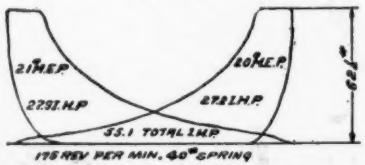


These pumps have already been severely tested owing to the discovery of water in the tunnel some time ago, when temporary piping and connections were hurriedly made and the pumps were pressed into use at short notice, being in operation day and night, and performing good service. The inflow of water was entirely taken care of, causing but a slight interruption in the completion of the work.

A New Four Valve Engine.

A NEW type of four valve engine was recently placed on the market by the Atlas Engine Works, of Indianapolis.

Especial attention has been given the matter of steam economy in the design of this engine, and a number of very radical improvements have been made with this in view. Chief among these is the placing



of the steam and exhaust valves directly in the cylinder heads, rather than at the top and bottom of the cylinder, as has heretofore been the custom. This results in a reduction of practically 4 per cent. in

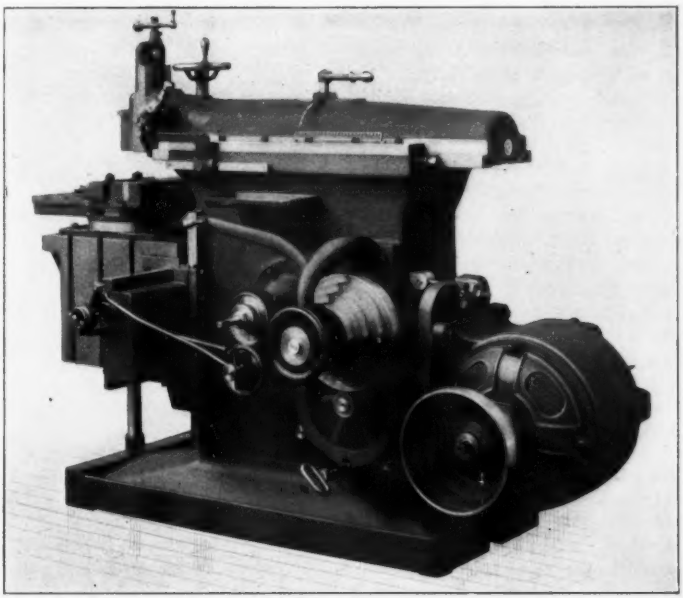
the clearance, and it will readily be seen that the saving of steam effected in this way is quite material. This also involves keeping the entire top of the cylinder and the upper portion of both heads constantly in contact with live steam, in this way greatly reducing the loss from cylinder condensation.

The simplicity which characterizes the entire valve gear is another point which is very commendable, and which cannot fail to appeal very strongly to the engineer. The bell crank and toggle joint common to practically all existing types of four-valve engines has been entirely done away with, and a great deal of the lost motion which they invariably entail, has in this way been eliminated. The steam valves are operated directly from a movable eccentric forming a part of the automatic shaft governor, and are entirely independent of the exhaust valves. The latter are operated from a fixed eccentric on the main shaft, in this way insuring uniformity of compression under all conditions of load and pressure. The connections are all of the "straight line" type, and involve no multiplicity of parts.

Both the steam and exhaust valves are double ported, and it is claimed that practically no wire drawing of steam whatever exists in this type of engine. Various tests made in the Atlas shops, as well as in the field, indicate a steam consumption practically identical with that of the Corliss type, and a regulation of from 1 to 1½ per cent. under changes of load from friction to full rated capacity.

Shaper at Liege Exposition.

THE intention of the designers of the shaper shown herewith is to make it the most powerful shaper of its stroke on the market. In doing so, they have not overlooked the fact that it should have the necessary rigidity to withstand the peculiar and excessive strains to which it is subjected. Neither have they overlooked accuracy in the system of jigs and the various tests to which the parts are subjected, insuring as perfect a tool as can be made at the present time. The column is of unusual width and depth, is ribbed and braced internally, and of a form to resist to the highest degree the peculiar strains to which it is subjected, while the horns projecting at the front and back give an unusually long bearing to the ram. The

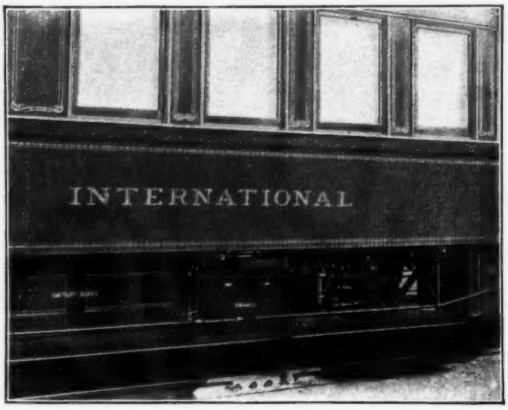


rail is deep, ribbed horizontally and strongly gibbed to the column, and the cross traverse screw is provided with a graduated collar reading to .001 of an inch. It is also provided with a variable automatic speed, changeable from nothing to full feed while the machine is in motion.

The machine shown herewith is now on exhibition at the Liege Exposition, Belgium, but the motor attached to it there is different from that shown in the photograph. The motor shown is of American make, and for this reason does not fit the motor pad prepared for the European make of motor. The shaper was made by the Cincinnati Shaper Co., Cincinnati, Ohio.

Electric Train Lighting.

THE salient features of the Deutsch system of electric light for railway passenger cars are reliability of operation and low maintenance cost. The elimination of delicate moving parts, the simplification of electrical connections and the provision of a direct-connected drive, which at the same time allows the wheels to be easily changed, has resulted in an equipment on which any inspection and repairs can be made without jacking up the car and which can be maintained by a cheaper class of labor than has heretofore been found necessary. It is conceded that the electric light is ideal for railway passenger cars and that the axle light or unit system is best for general service if it can be maintained efficiently and cheaply. The advantages of this method are, that each car carries its own equipment, and therefore permits of greater flexibility in the make-up of trains and no auxiliary compressing or charging plants are required.



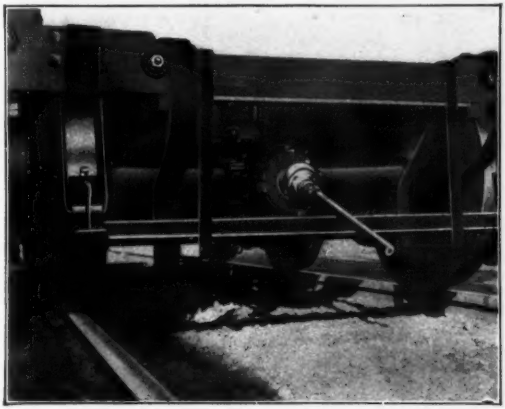
The Deutsch system consists of a dynamo hung from the car body, a regulator, located in any convenient place in the car, a transmission or drive and usual storage batteries. The storage battery is intended to supply current for the lights when the train is standing or running at less than a specified speed. The battery can be relied upon to perform this service if it is properly charged when the train is running.

The drive consists of a steel bevel gear provided with a suitable hub extension, forming a bearing immediately adjacent to the tooth face. The gear is attached to the axle and rotates therewith. Encircling the bearing above mentioned, is a steel strap to which a stud is electrically welded. This stud forms a bearing support for a raw hide pinion which is designed to co-act with the steel gear and to which is fastened the shaft for driving the dynamo. The shaft is telescopic and is provided with universal joints to allow for axle play and side motion of truck on curves. Any tendency of the strap to revolve with the gear around the car axle is counteracted by a rod or arm projecting upward from the same and flexibly supported by the truck frame. A steel gear casing is cast integral with the strap, thus making the gear casing, strap and pinion bearing in two pieces which are bolted together and carried by the hub bearing of gear. It can thus be seen that both the gear and pinion are supported directly from the axle, that is to say, the driving gear wheel is attached to the axle and the pinion meshing with it turns on a stud forming part of the strap which surrounds the gear bearing and moves coincidently with the gear wheel in every movement of the axle, thus insuring perfect engagement of the teeth under all possible conditions.

The dynamo is rigidly suspended under

the car body. The bearings are self-aligning and ring oiled. The wear on the bearings is insignificant since there are no strains due to belt pull and the flexible nature of the shaft connection prevents any shock from being transmitted to the dynamo. This it can be seen is a material advantage over any belted equipment.

The accessibility of parts is exceptional. The armature can be removed, a new one



substituted and everything put in proper shape for immediate service in fifteen minutes. Both bearings are the same size and all screws holding removable parts are standard and of the same size. The casing can be removed, completely exposing the machine for inspection, in one minute, by simply slacking two wing nuts and the armature or bushings can be renewed without disturbing a single electrical connection.

The essential parts of the regulator are, an automatic switch, a controlling solenoid, an air valve, a cylinder, piston working in the cylinder and carrying electrical contacts on the rod thereof, and a resistance located in the shunt field circuit of the dynamo.

The automatic switch cuts the dynamo in and out of the lamp circuit above and below a specified train speed, that is to say, when the train runs below the specified speed, the lights are on the storage battery, and above that speed, they are on the dynamo. As the train speed increases and as the dynamo turns faster than the speed required for maximum output, the controlling solenoid opens the air valve and admits air back of the piston, which raises and carries with it the electrical contacts attached to its rod and cuts resistance in the shunt field circuit of the dynamo, thus reducing its output. When the train speed decreases, the air valve is closed by the controlling solenoid and the piston drops by gravity, thus cutting resistance out of the field circuit until the dynamo output is again at its normal maximum. This regulator does not depend upon electrical means for its operation, but is driven by compressed air from the brake mechanism, thus insuring a reliable and dependable method of controlling the output of the dynamo.

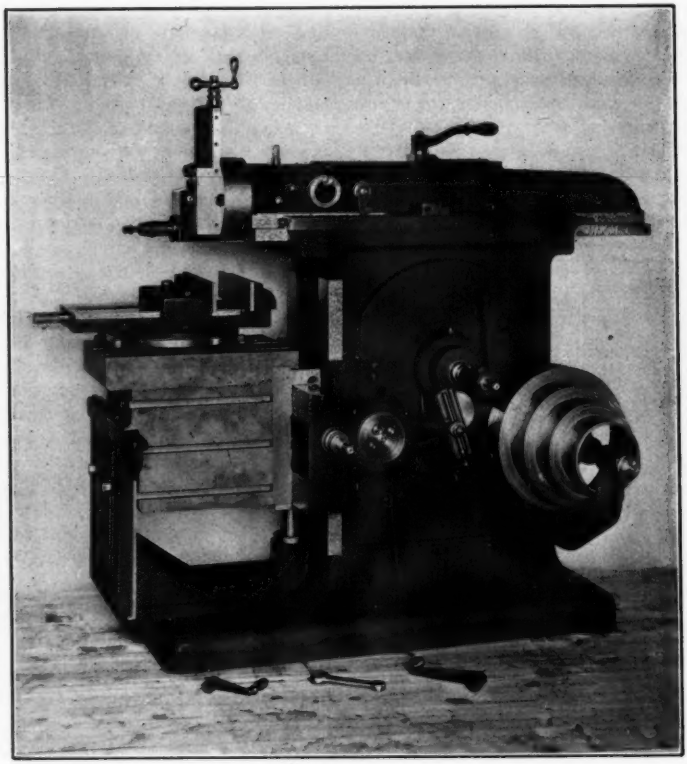
A very small volume of air is required at about 15 pounds pressure. Its working is noiseless and there is no motion except when the train speed materially changes. There are no rotating parts to cause trouble and all electrical connections are conveniently arranged.

The Electric Controller & Supply Co., of Cleveland, are licensees of the Deutsch patents for the United States, Canada and Mexico, and will supply any further information desired.

Stockbridge Shaper.

AMONG interesting features of a new design 20″ shaper made by the Stockbridge Machine Company, Worcester, Mass., the following are worthy of note.

It possesses automatic feeds to both head and table, adjustable while the machine is in motion. The table is supported the entire width when in any position on the bar and is raised sufficiently above the saddle to allow T bolts to be put in from the back as well as from the front. The table hooks over the saddle, thus giving greater rigidity to it than when bolts alone are used. All backings are tapered. The driving gear is 20″ in diameter with a 3½″ face. This, together with back gears and the four step cone to carry a three-inch belt, would make this a very desirable ma-



chine, but, besides this, in common with all shapers made by the same house, it is equipped with the Stockbridge two-piece crank motion, which gives a powerful and even cutting speed the entire length of the cut together with a quick return. The gear and crank are so constructed that it has the same rigidity on a long stroke as on a short one, insuring a cut as free from shatter on a twenty-inch as on a five-inch stroke.

Test of Reeves Engine.

PROF. H. DIEDERICHS, department experimental engineering, Cornell University, has recently made a series of tests of the Reeves engine to determine economy and mechanical efficiency, and to observe the behavior of the engine under various loads and steam pressures.

The engine is a vertical cross compound. Steam is admitted to the high pressure cylinder by a piston valve which takes steam from the inside edge. This valve is under control of a Rites shaft governor. The steam exhausted from the high pressure is admitted to the low pressure cylinder by two piston valves of identical design, operated by an eccentric from the engine shaft. There is no receiver, and the steam from one end of the high pressure enters the same end of the low pressure. All the piston valves are so designed that, by means of expansion rings, wear can be taken up at either end of the valve by adjustment from the head end only, making it necessary to remove but one valve chest cover for each valve. Cylinders and valve chests are well lagged, and lubrication in the cylinders was taken care of by sight feed lubricator and hand pump.

The engine frame is of standard design, as are also cross-heads, rods and bearings. The whole engine gives one the impression

of solidity and finish. There was, however, no indication whatever that the engine had been specially prepared for a "parade" test.

Lubrication of bearings is taken care of by a central oiling system, all oil pipes leading from a tank placed at the side of the cylinders. By this means, once the oilers are set, lubrication can be watched from one point.

Arrangements and Methods of Tests: The engine was connected through about 25′ of 4″ pipe to two B. & W. boilers. This pipe was one size too small, but was the largest that could be obtained for connection. In order to minimize the effect that the resulting high steam velocity would have, a piece of 6″ pipe about 30″ long was interposed to act as a sort of reservoir just ahead of the throttle-valve.

About 20′ of 7″ pipe connected the engine to a Wheeler surface condenser.

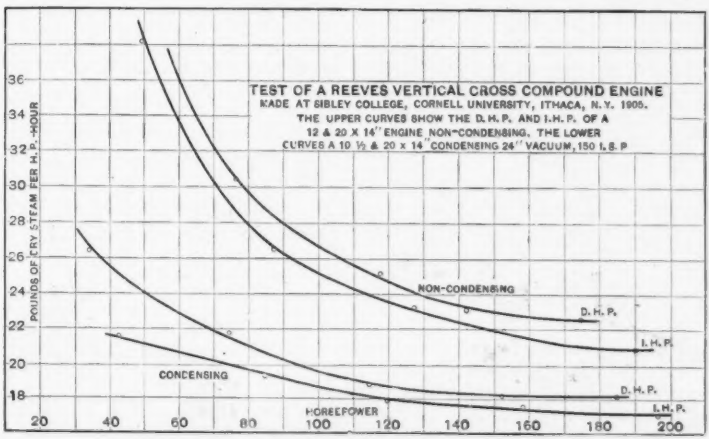
A Carpenter throttling calorimeter, placed beyond the throttle valve served to determine the quality of steam. The steam pressure was determined by a gauge connected next to the calorimeter.

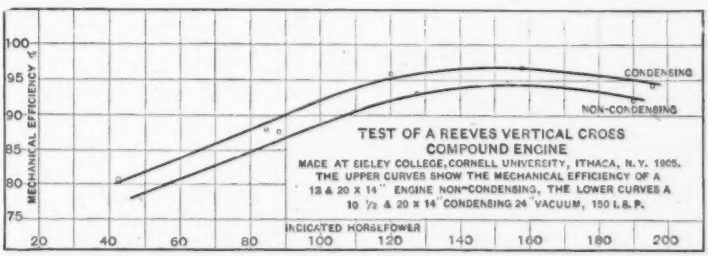
The speed was found by a continuous counter, and by hand counter as a check. The continuous counter readings were used in the calculations as being absolutely correct.

One Thompson indicator was connected to each cylinder, taking cards from each end by means of a three-way cock. Motion for the indicators was obtained by fastening a rod to each cross-head, the stroke being reduced by means of a reducing wheel fastened to each indicator.

The condensed steam was pumped by the air pump alternately into two tanks on scales. Readings of condensed steam weights were taken every five or ten minutes, as the load demanded.

For the purpose of test the engine was fitted with a fly-wheel 5 ft. in diameter on





the low pressure side. Upon this wheel was placed the Prony brake for the determination of the developed horse power. This brake was, in all respects, of the ordinary standard design, the strap being of steel plate, fitted with wood blocks on the inside. The wheel was kept as cool as possible by running cold water constantly into the flanged rim, and taking it out by a scoop. A steady small stream of cylinder oil led under the strap helped considerably in the smooth operation of the brake. By these arrangements as much as 185 D. H. P. were taken off one brake.

For the condensing series as high a vacuum as could be obtained was carried. This averaged about 24". For the non-condensing series the air-cock on the condenser was kept open, insuring condensation under atmospheric pressure.

For the condensing runs the engine dimensions were 10½" and 20" x 14"; for the non-condensing runs, 12" and 20" x 14". This change was effected by taking out a liner from the high pressure cylinder. These dimensions make the cylinder ratio in the first case 3.60, in the second, 2.75.

The steam consumption per I. H. P. and per D. H. P. for various loads and steam pressures is computed on the basis of dry steam.

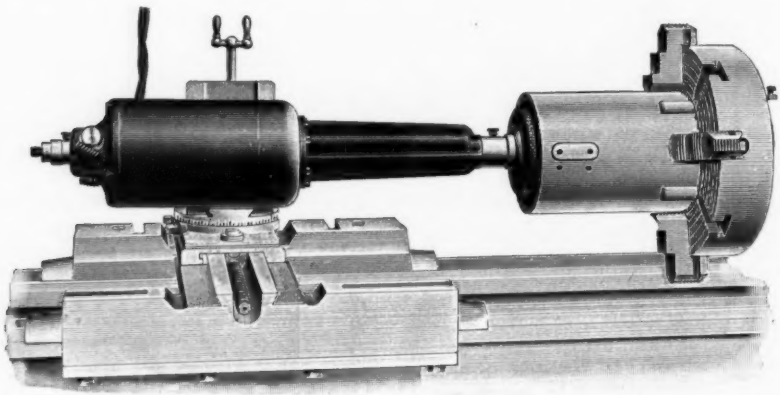
For the purpose of facilitating inspection of results and discussion, the water rates and mechanical efficiency are plotted on the accompanying curve sheets.

Two things are to be noted about these curves. The cut-off even at the high loads does not seem to be late enough to cause any marked rise in the steam consumption at overloads. In fact, in most cases little or no rise could be determined. Again, the curves show good economy over a wide range of load.

The mechanical efficiency curves show a steady increase with the load at any given steam pressure. On the overloads the efficiency falls off but slightly.

Portable Electrical Internal Grinder.

WE here illustrate a new tool especially designed for the grinding and finishing up of gas, steam and air cylinders, grinding out hardened dies, truing up bearings and internal cylindrical grinding of any kind. This machine is bolted to the tool-post rest of a lathe, through the base of the angle plate on the back of the motor and has a vertical adjustment. It has a grinding depth of 12", although it can be furnished up to a 20" depth if desired. The minimum size of hole it will grind in is 3½". The motor dimensions are 6" x 12", extension spindle 12", length over all 24", weight 76 pounds, 1 horse power capacity. The driving power is derived from the ordinary incandescent lamp socket, direct current, from 50 to 250 volts.



The makers, Hisey-Wolf Machine Co., Cincinnati, Ohio, will furnish fuller details upon request.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Magnetic Controllers on Ore Unloaders.

THE Hulett automatic ore unloaders built by the Wellman-Seaver-Morgan Company, and installed at the docks of the National Tube Company, at Lorain, Ohio, are operated entirely by magnetic switch controllers.

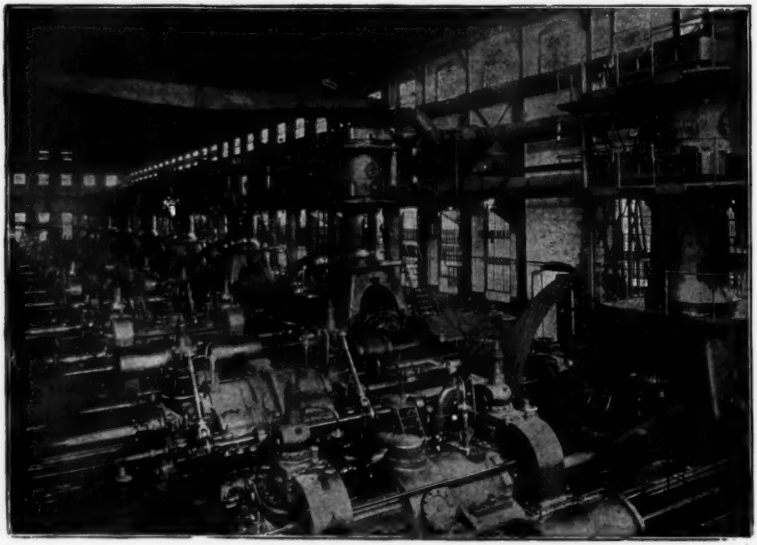
The controllers proper consist of a number of magnetically operated clapper switches which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch-panel. The main contact of each switch is a heavy laminated copper brush reinforced with a yellow brass contact, the final break being taken between carbon contacts and the arc quickly ruptured by powerful magnetic blow-out. These switches are operated by a small master switch located in the operators' cabs. The wires connecting the master switch with the controller proper are of very small size, as they are required to handle only a few amperes.

Each motion of the unloaders is provided with a positively connected or geared automatic cut-out or emergency switch. The cut-out on the hoist and bucket-car

HULETT AUTOMATIC ORE UNLOADERS AT LORAIN, OHIO.

motions automatically slows down and stops these motions as the limit of travel is reached. They first operate to gradually introduce resistance and slow down the motor. Then they change connections to convert the motor into a generator, thus applying a gradual dynamic breaking effect until the motion is nearly stopped, when the solenoid band brakes are automatically applied. The bucket rotation and trolley motions are supplied with geared automatic slow-down and cut-out devices which gradually insert the resistance and finally apply solenoid band brakes to stop the motion as the limits of travel are approached. While all of these automatic devices fully protect the machinery and motors against failure of current supply, confusion, faults, and failure of the operator, still the operator has full control of the motor at all times.

All the controllers, solenoids and other electrical details were designed and manufactured by the Electric Controller & Supply Company, Cleveland, Ohio.



LACKAWANNA STEEL CO. POWER PLANT AT BUFFALO.

Economical Lubrication.

THE Lackawanna Steel Co., Buffalo, N. Y., is equipping its engine plants for utmost economy of oil usage and hauling at these mills. There are installed 48,000 horse power of engines. Five Allis-Chalmers vertical cross compound steam engines give 16,000 horse power for driving roll trains, etc. There are two blowing engine houses, each with eight units driven by 2,000 horse power Koerting gas engines. The illustration shows the interior of one of these plants. The complete power installation of 48,000 horse power is now being equipped with the "White Star" continuous oiling system manufactured by the Pittsburg Gage & Supply Co., of Pittsburg, Pa. By this system the oil is distributed continuously to all bearings, keeping them constantly supplied with just the right amount of oil to insure best results. All drips and used oil are drained away to the "White Star" filter, which constitutes one feature of the system. Passing into the filter it is there cleaned of all impurities, and is then pumped to storage tank, whence the oil is returned to the circuit. Loss of oil is avoided entirely, the only means of escape from the system being by actual wearing out in the bearings. This, of course, means the greatest possible economy.

Consideration of usual conditions will readily show the experienced power user how easily this system may effect a saving

of at least one-half the oil, eliminating waste losses and insuring actual use of every drop. About two years ago the power plant of the Union Steel Co., Donora, Pa., was equipped with the "White Star" system. Previous to this installation, a 38 and 75x60-inch twin tandem compound condensing engine, Porter-Allen type, required an average of 1,050 gallons of engine oil per month. This has been cut to an average of 503 gallons under similar conditions—a saving of more than 52 per cent. In this same plant on two 30 and 60x48-inch engines, the oil consumption was reduced from 400 gallons to 195 per month, operating full. As a further item of saving directly credited to the "White Star" system, the service of three oilers required under the old regime were dispensed with from the start. The wage account, therefore, also shares in the general economy. Bearing upon this general subject of modern engine lubrication, the Pittsburg Gage & Supply Co. have some interesting literature which they forward to anyone interested.

Hollow Building Block.

DURING the past three years we have undergone an extraordinary period of education in regard to cement construction, but perhaps no branch has attracted attention equal to the hollow concrete block problem. During twelve years previous to this there was only one person, so far as known, studying with the special object of making hollow concrete blocks practical for use in general building. Hollow blocks previous to this had been produced in the most crude and cumbersome manner and at such cost as to preclude their general use, besides, up to this time, their shape and character were not adapted to use by reason of the fact that to cut and trim hollow blocks was much more wasteful than with solid ones, owing

PALMER CONCRETE BLOCK MACHINE.

STAUNTON MILITARY ACADEMY. BUILT OFHOLLOW CONCRETE BLOCKS.

to the liability of shattering while cutting. However, this difficulty is overcome by a system of dividing them according to units of measurement. This unit was also to be observed in fixing the dimensions of frames for doors, windows, etc., thus making it possible to build a house without cutting a single block. It was this principle which first brought favorable attention to hollow blocks, and which was patented by H. S. Palmer, in 1899. The system developed such favorable comments that many began to engage in the business without regard to this important point, and machines were made and sold lacking in some of these most essential points.

During the past two or three years many hollow block houses have been a disappointment to their owners and occupants by reason of some of the following defects: Porosity of the concrete blocks, discoloration, cost of manufacture, cracking in the wall, crazing or hair cracks, besides others of less account. It is impossible here to go into but a very few details showing why any defects should exist in hollow block construction. However, some of the most palpable defects can be traced directly to the construction of the machines on which the blocks were made, and one requisite must be the ability to compact the mass into the smallest degree possible and hold it there. For this purpose the wedge is employed, by which a greater power can be given to compacting concrete than hydraulic pressure. This is carried out in the following manner:

The molds must be of sufficient weight to withstand ramming without shaking or trembling so as to loosen the mass after it has been driven into the molds by the rammers. With this feature properly attended to the next is the shape of the mold by which the compacting can be retained. For this purpose the walls of the mold should not be too far apart, and in practice from two to six inches is the best. In addition to this they should be somewhat inclined, making the mold smallest in the bottom. With these points properly adjusted the next thing to consider is the proper condition of the mixture or "stone paste," which is made of cement and sand, gravel or other aggregate. When this paste is exactly right it is shoveled into the mold and rammed down hard. The mold grips the material, each blow adding to that already given, and, retained in connection with the sticky condition of the proper mixture, compacts the same into the smallest space. Thus the density, strength, porosity and lasting qualities of the stone are greatly enhanced, as well as a more even and uniform color with less liability to efflorescense and cracking.

Stone made in a mold whose walls are twelve inches apart cannot be as compact as that made in one whose walls are only three inches apart and properly inclined. It was this most important feature that made the manufacture of hollow blocks a success, because when the cores were in position the thickness of the walls of stone would be the most advantageous for ramming while the tapering cores produce the wedge-shaped mold and the ideal condition for perfect stone making. It is this principle which explains why better impressions are given to the stone by the sides of the mold than could be obtained from the bottom.

The machine herein shown embodies this principle and is the same as the first successful Palmer machines. In the rush to keep up with the demand during the first few years after the success of the industry was acknowledged, the automatic features of the machines were omitted, but as the trade seemed to demand something new they have been added. Other features are the means for making all sizes of blocks, all angles, all thicknesses and widths and innumerable designs.

There are now more than three hundred factories in operation using Palmer machines. The view of the Staunton Military Academy shows the work of a user of the Palmer machine.

Steam Turbines in Japan.

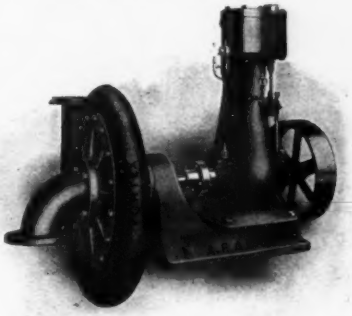
CHARACTERISTIC of the present progressiveness of Japan is the fact that outside of Europe and the United States this small nation is the largest user of steam turbines in the world. With the industrial awakening of the Island Empire has come a need for electric power not only for manufacturing purposes, but for transportation and for lighting. The enterprise of Japanese engineers is nowhere more

clearly indicated than in their adoption of steam turbine electric generating units. On July 29, 1904, the first shipment of steam turbines arrived in Japan. They were of 500 kilowatt capacity of the Curtis type, and were for operating the Shigai railway in Tokio. Four weeks from their arrival they were in full operation. As significant of the success of these first units, there have been ordered by the Japanese from the General Electric Company, of New York, thirty-seven Curtis steam turbines with electric generators, with a total normal capacity of more than 40,000 horse power. Of these, eleven units are now installed and in satisfactory operation.

Vortex Centrifugal Pumps.

FOR elevating liquids to moderate heights quickly, cheaply and efficiently, the centrifugal pump possesses peculiar advantages. They are used largely in paper and pulp mills, tanneries, bleacheries and dye houses, print works, chemical works, cotton and woolen mills, for draining and irrigating land, for pumping out dry docks, for wrecking, dredging and mining purposes, for circulating water in surface condensers, for raising sewage, for pumping out coffer dams and excavations, for general contractors' requirements, for circulating purposes in hot water heating systems, and in connection with filters.

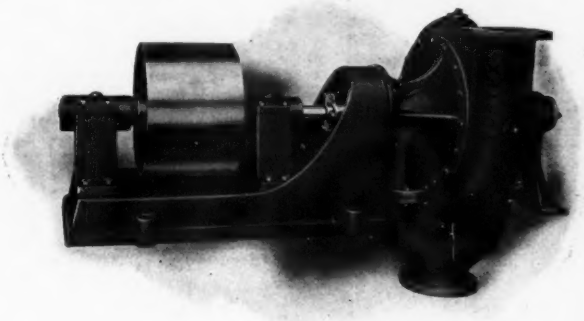
The Vortex pumps shown herewith are built from new designs and show several desirable features and improvements suggested to the manufacturers in an experience of nearly twenty years in designing, building, erecting and operating centrifugal pumping machinery. The double suction types are built in two classes. One with



VORTEX PUMP AND ENGINE.

large propellers, designed for high elevations or comparatively slow speeds, is especially well adapted for direct connection to engines. The second class is designed for moderate elevations and medium speeds, the propellers being considerably smaller than in the other class.

A booklet issued by the makers, Lawrence Pump and Engine Co., Lawrence, Mass., gives much interesting information on centrifugal pumps and their uses.



VORTEX CENTRIFUGAL POWER PUMP.

High Speed Chain Hoist.

A NEW driving arrangement is the distinguishing feature of a chain hoist recently put on the market by the Chisholm & Moore Mfg. Company, Cleveland, Ohio. The life wheel or sprocket wheel which

carries the lift chain is cast in one piece with the spur wheel that drives it. This double wheel turns freely upon a hollow shaft rigidly supported at both ends in the frame. The spur wheel is encircled by a yoke having internal teeth meshing with the spur wheel teeth and driven with a gyrating movement about it by two eccentrics diametrically opposed. The hand wheel shaft passes through the hollow main shaft and carries at its further end a pinion which drives two spur wheels, one on each of the two eccentric shafts.

The number of the teeth in the spur wheel divided by the difference between the

CYCLONE CHAIN HOIST.

INTERIOR OF YOKE.

GEARS ON BACK.

number of the spur wheel teeth and the number of the internal teeth of the yoke, equals the number of revolutions of the eccentrics necessary to turn the live wheel once. The teeth are accurately cut, work smoothly together and there are a number of them in contact, which insures great strength. The eccentric shafts have bearings at both ends and run in roller bushings in the yoke. All other bearings have self-lubricating graphite bronze bushings. There are no overhanging bearings in the hoist, so that under the full load the frame will not spring and bind the working parts. The extreme simplicity and great strength of this construction is apparent. It is as practicable for the 20-ton size as for the ½-ton, without undue increase in weight or size.

The friction loss of the movement is so slight (the efficiency is about 80 per cent.) that it has been found practicable to gear the hoists to a very high speed without increasing the hand wheel pull above that of other slower hoists. The 1-ton Cyclone overhauls only 29½ feet of chain to raise the maximum load 1 foot with a pull of 125 pounds. It is claimed that the load can be raised with the Cyclone hoist more than twice as rapidly as with the best types of screw hoists.

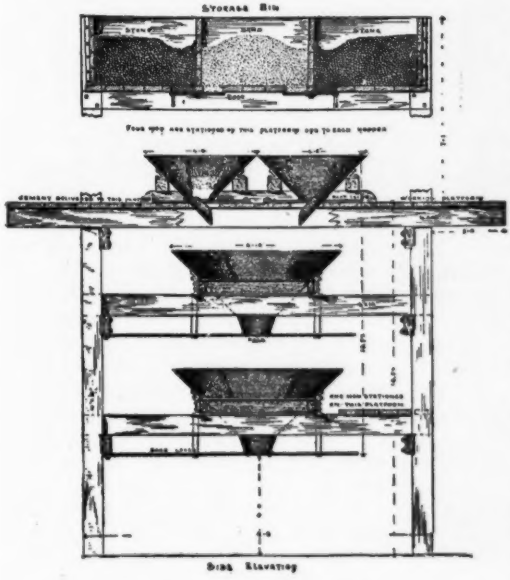
An automatic brake permits the spinning of the hand wheel in either direction when there is no load, locks the load with perfect safety and yet permits free lowering by a very slight reverse pull on the hand chain.

Hains Concrete Mixer.

TO insure an intimate mixture of the materials of which concrete is made machines of various kinds have come into general use. It is commonly admitted that the cubical mixer possesses the advantage of turning out an excellent concrete, but it is of limited capacity; while most gravity mixers, working with greater rapidity, do not cover every piece of stone with the paste formed of cement and water. The Hains mixer was designed with a view to combining the advantages of both. It consists of a series of funnel shaped hoppers provided with doors at the bottom, by means of which the ingredients are passed from the upper to the lower at will. At first sight one would call it a gravity mixer, but it is really no more a gravity mixer than a cubical mixer. It is automatic in its action. The cubical mixer is turned about on an axis and the ingredients fall over each other as the sides of the cube vary their inclinations to the vertical. In the Hains mixer the sloping sides of the

hoppers are constructed at such angle that the ingredients tend to fall inward at the center first, and the outer portions to follow in the same manner. It is this that causes the ingredients to mix. When the ingredients are passed from one hopper to the other they come out at the bottom well mixed concrete.

The four top hoppers are set on a frame support, which latter also carries a platform on which the men are stationed to load the cement, sand, and broken stone. The cement is first put into the top hoppers, is leveled off and the proper proportion of sand and broken stone added, which should also be leveled off. The necessary quantity of water is then sprayed over the top of the stone. The cement, being in the form of an impalpable powder, acts as a



HAINS CONCRETE MIXER.

dam and remains dry, the sand and stone only becoming wet. The doors or gates of the top hoppers are now opened and the four small batches pass through the contracted orifices into the hopper below. When this hopper has been filled its door or gate is opened and the contents pass to the next hopper below.

It is thus seen that the concrete does not run continuously through the hoppers, but is dropped from one tier to the other, the hopper last emptied being always ready to receive the charge from the one above it, so that the process of mixing becomes one of a rapid succession of steps. The limit of its rapidity to mix is only determined by the speed of handling the ingredients.

Further details of this interesting concrete mixer will be sent upon request by R. B. Lawrence, 39 Cortlandt street, New York.

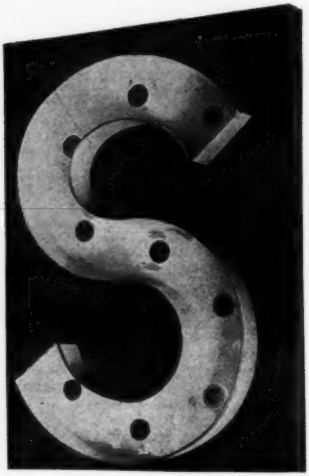
Foster Pressure Regulators.

THE regulation of steam, air and water pressures enters to an increasing extent into modern engineering and industrial operations, with the growing tendency in favor of central power generating plants. To obtain the full benefit of this centralization of power, means must be employed for reducing the pressure of air and steam from the high pressures most economical for distribution to the lower, practicable working pressures. The pressure regulators manufactured by the Foster Engineering Co., Newark, N. J., have proved exceptionally successful for this purpose. Their "Class W" pressure regulator is a standard device, in which the valve governing the pressure is controlled and operated by the movement of a diaphragm, opposed to the action of springs, whose tension is adjusted according to the delivery of pressure to be maintained. This pressure is entirely independent of pressure in the supply pipe. The regulator is delicately accurate, positive and reliable and is in successful use in many manufacturing establishments, mines and other places where power, steam or compressed air, distributed from a central source, requires regulation and reduction. The Foster Engineering Company are makers of a number of practical pressure regulating contrivances. Their cata-

logue, which may be had for the asking, describes them.

Electric Signs.

SOME of the largest manufacturers are advertising themselves and their product to advantage and at a comparatively low cost by placing electrically illuminated



ELECTRIC LETTER "S."

signs on the roofs of their factory buildings. These buildings are usually located near some well traveled railroad, and naturally the signs are read during the evening hours by a great many buyers from all parts of the country. These factories nearly all have their own electric light plants, and the operating expense of a well-built and substantial sign is therefore exceedingly

COMPLETE ELECTRIC SIGN.

small. A well constructed electric roof sign should consist of all metal grooved or channel type letters, usually made from two to nine feet high, according to the distance at which they should be plainly readable, mounted upon an angle iron frame. The channels or grooves of the letters are white enameled, the light thus being concentrated and reflected from these surfaces. It is not necessary therefore to place the sockets very closely together, and to use anything better than 4 to 8 candle power lamps; a current saving of from 25% to 30% is thus effected over the methods of construction. Moreover, a sign built with these letters can be distinctly read at an exceedingly sharp angle. When read at an angle, raised letter signs become blurred. These signs may also be built with full metal backgrounds, as shown in the cut of the letter "S" on this page. The other cut represents a complete metal sign made for a manufacturer for advertising an exhibit.

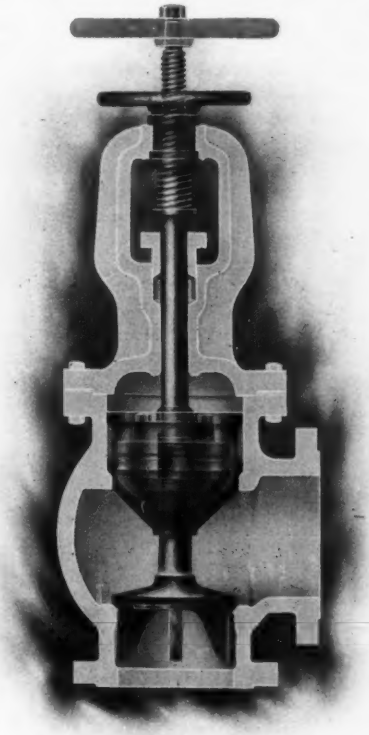
These constructions have been thoroughly developed and put into actual practice by the Haller Machine Co., Chicago, who are prepared to submit designs and quotations on anything in this line. The same firm also manufactures a line of electrically driven direct connected vacuum pump and air compressor outfits of ¼ and ½ horse power capacity.

Hydraulic Jacks.

UNLESS a hydraulic jack is absolutely reliable the engineer, mechanic, railroad man or whoever is using it is better without it. Just at the critical moment, when everything depends on a jack's "standing up," a poorly made device is liable to give way. In the Watson-Stillman hydraulic jacks every such element of uncertainty is eliminated, hence the confidence reposed in them by those who have to trust life and limb to the dependability of a hydraulic jack. The cylinders and rams, for which in some makes seamless tubing is thought to be good enough, are in the Watson-Stillman jacks forged from solid steel billets, forged and bored like the cylinder of a high class steam engine. Valves, glands, pistons, etc., are made and finished with equal care. Packings and other parts subject to wear are easily accessible and replaceable, the result being a hydraulic jack thoroughly dependable and constantly ready for service. The manufacturers, Watson-Stillman Co., 46 Dey street, New York, have a list of about 300 styles of hydraulic jacks, which they will send on request.

Cushioned Non-Return Valve.

THE Golden-Anderson Valve Specialty Company, Pittsburg, Pa., are manufacturing the Anderson cushioned non-return valve, in three types. The modern power station, large manufacturing plant, mine, blast furnace and steel mill, with their high steam pressures and many branch pipes, has necessitated the use of a valve to act as a safeguard in emergencies such as the bursting of tubes, pipes or fittings, or other accidents. When such accidents do occur, it is impossible to shut off the ordinary gate valves and globe valves, thus causing loss, and the injury or death of the attendants. These valves are designed to avert this constant danger. They also, when placed between the boiler and the header, will equalize the pressure between the different units of the battery of boilers, as they remain closed as long as the boiler-pressure is lower than that of the header. When the boiler pressure equals the header, they open and will remain in that position without chattering or hammering. They will also act as a safety stop to prevent steam being turned into a boiler while men are working inside. Their correct mechanical construction makes them especially adapted for superheated steam service. The inner dash-pot is attached to the end of the valve-spindle, the outer one being loose on the spindle. When the steam pressure raises the valve, there is immediately a space between the inner and outer dash-pot which causes a perfect cushioning for the valve, preventing any hammering or chattering on the seats.



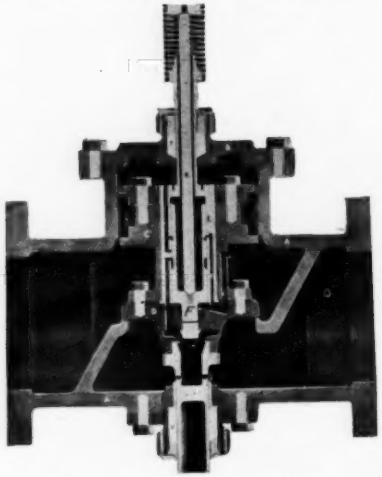
CUSHIONED NON-RETURN VALVE.

Waring Steam Pressure Regulators.

IN nearly every manufacturing establishment there are situations in which it is required to use steam at a lower pressure than is furnished by the boilers which supply the engines. Modern practice demands high-pressure steam for the engines, in order that the best economy may be effected, and hence there is a necessity for an effective and reliable pressure regulator which shall take this high-pressure steam and reduce it to any required lower pressure for use in heating pipes, drying apparatus, coils, vats, and innumerable other purposes in which the heat of the steam without its pressure is needed.

It is to meet these requirements that the Waring pressure regulator has been devised, and in practice it has been found to fulfil most completely the conditions occurring in active service. The principle upon which the Waring pressure regulator is constructed is that of throttling the

high-pressure steam down to the required low pressure by means of a valve, the opening of which is controlled by the pressure on the reduced side of the valve. The high-pressure steam enters beneath the valve, and lifts it, passing through and being throttled down to a lower pressure in the course of the passage. The valve is attached to a piston, fitting in a cylinder



WARING PRESSURE REGULATOR.

above, the lower portion of this cylinder being open to the reduced-pressure steam. The upper portion of the cylinder has access to it controlled by a valve, marked F in the illustration, this valve being held down by the spiral spring seen at the top. This controlling valve is lifted as soon as the pressure beyond the main valve exceeds the resistance of the spring, and thus high-pressure steam is admitted to the space in the cylinder above the piston, forcing it, and the main valve to which it is connected, down again, and reducing the opening through which the high-pressure steam must pass. The pressure at which this action occurs can be closely regulated by adjusting the spring, after which the desired pressure will be automatically maintained on the reduced side of the valve no matter what the pressure on the high-pressure side.

It will be seen that this valve differs materially from earlier types in which the entire operating mechanism had to be actuated in one direction by a spring and in the other by the steam. In the Waring valve the power of the steam is employed for all the movements of the regulating valve, there being no diaphragms, weighted levers, or objectionable features, while the controlling action is effected by a small pivot valve and a correspondingly small and light spring, easy of adjustment and certain and prompt in action. The valve is designed upon a principle now generally accepted in all mechanism of the highest class, that of separating the operative parts from the controlling portion, so that no work is thrown upon the latter, to diminish its sensitiveness or impede its action.

Tests of the Waring pressure regulator have demonstrated that any desired low pressure can be maintained upon one side in spite of great variations in the pressure of the steam delivered to it upon the high-pressure inlet, so that it can be depended upon for the automatic maintenance of a low-pressure service in any situation.

Valves upon the same principle are constructed for the regulation of water pressure, and these will be found useful wherever water is delivered at a high and variable pressure to factories or buildings in which a uniform lower pressure is desired.

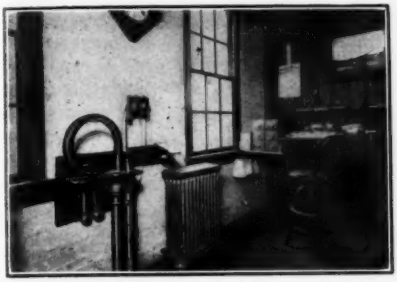
The Waring steam pressure regulating and reducing valves are manufactured by William G. Coats, 45 Clinton street, Newark, N. J., to whom all inquiries should be addressed.

Mechanical Messengers.

AN interesting modification of the well-known cash and package carrier makes it a valuable labor saving and time saving appliance in office and shop. The Lamson pick-up and delivery carrier now affords an automatic and quick means of intercommunication for office and factory, not only saving the expense of messenger service, but, as a mechanical aid to business systems, it increases the efficiency of the organization. It has been found especially useful in the transportation not only of shop orders, job tickets, time slips, etc., but for the delivery and return of blue prints and tracings.

As an adjunct to the tool room and stores room it is especially valuable. Re-

quisitions and orders for tools and parts can be deposited in the carrier in any department, and the tool room clerk or stores clerk can send back to the person making the requisition the tool or part required. In addition to the saving of time and expense of messengers, the delivery is very much quicker than can be accomplished by a messenger, and delivery to the right person is positive. The carrier can make no mistake, performing its work with unvarying accuracy and tireless persistency. Nor does it allow work to accumulate, but handles it continuously. By its use the stream of business routine is kept flowing steadily and briskly in its proper channel.



CARRIER SYSTEM OF AMERICAN OPTICAL CO.

The possibilities are many, and the small cost of installation and the insignificant item of maintenance recommend it to the comparatively small plant as well as the large one.

The Lamson Consolidated S. S. Company, Boston, Mass., have made a large number of shop installations, of which we show two herewith.

Mechanical Draft.

MILLS and Rowan, in their exhaustive work on Chemical Technology, make the following statements regarding the subject of mechanical draft. "The principles of what is now becoming well known under the name of 'forced combustion' have been repeatedly advocated during past years by those who have devoted thought and study to the subject. The position assumed by them—which is now finding favor amongst engineers—has been, in brief, that the air supply required for combustion in furnaces can be more economically furnished by mechanical power than by the action of chimneys; and that the mechanical method has other advantages, which enable it to be preferred to the one which is older, but more imperfect. One of these advantages is the higher temperature of combustion, which is equivalent, with a boiler of good design, to an increased evaporative power of the boiler, or to increased evaporative effect for the fuel. Another advantage, which has not been fully realized in any plan as yet introduced in practical work, is that the rate of travel and escape of flame and hot products of combustion is under control. It is thus possible to cool them more completely than can be done when chimney draft is used, and this means a saving of heat which would otherwise be uselessly dissipated. Mechanical or artificial draft thus presents to us a method of economically furnishing the air supply to furnaces and producing a more efficient combustion temperature, while it also renders possible further economics due to retarding the movement and escape of hot gases, and to preliminary heating of the air supply by waste heat or otherwise."

CARRIER SYSTEM OF COE BRASS MFG CO.

NEWS SUPPLEMENT

The Engineering Magazine—September, 1905.

Personal.

—F. L. Sayer succeeds George H. Gibson as head of the department of publicity of the International Steam Pump Co.

—William Jessop, chairman of William Jessop & Sons, Ltd., died at his country estate, Bradfield, England, after a long illness.

—P. O. Herbert, 615 Peters Building, Atlanta, Ga., will represent the Eureka Fire Hose Co., as general sales agent, for the exclusive sale of its fire hose in the Southern States.

—George R. Wadsworth has resigned his position of resident engineer on the New York Central Railroad to accept a position on the staff of J. G. White & Co. as assistant to the construction superintendent.

—J. R. McColl, who was until the close of the last college term associate professor of steam engineering at Purdue University, has accepted a responsible position in the engineering department of the American Blower Co., Detroit.

—Warwick H. Payne, who for a number of years past has represented the Eureka Fire Hose Co. in the sale of its fire hose throughout the Southern States, with headquarters at Atlanta, Ga., died on the 9th inst. after an illness of several months.

—Halbert P. Gillette, formerly associate editor of *Engineering News*, and Geo. H. Gibson, formerly manager of the publicity department of the International Steam Pump Co., have formed a partnership as advertising engineers, under the name of the Geo. H. Gibson Co., with offices in the Park Row Building, New York.

—Harold U. Wallace, son of John F. Wallace, who has resigned the engineership of the Panama Canal Commission, has accepted the third vice-presidency of J. G. White & Co. H. U. Wallace resigns as chief engineer of the Illinois Central Railroad to accept this position. He has been connected with that road since 1894 and since 1902 has been its chief engineer.

Industrial Notes.

—The General Chemical Co. have installed a Morgan continuous gas producer in their works near Chicago.

—Owing to their rapidly increasing business the Power Specialty Co. has been compelled to secure more commodious quarters at 111 Broadway, New York.

—The Wellman-Seaver-Morgan Company, Cleveland, have established a branch office at 216 Dooly Block, Salt Lake City. Harry V. Croll, M. E., has been appointed manager of same.

—The Babcock & Wilcox Co. will use producer gas for heating their boiler heads and other forge work. The Morgan Construction Co., New York, has been awarded the contract.

—The Canadian White Co., Ltd., Montreal, has issued an announcement stating that they will carry on a general contracting and engineering business, on similar lines to J. G. White & Co., Inc., New York.

—The Pennsylvania Railroad are installing gas producers for forge work in their Altoona shops. The contract for the producers, building and equipment was awarded to the Morgan Construction Co., New York.

—Dayton Hydraulic Machinery Co., Dayton, has opened a New York office at 133 Liberty Street. They will carry a line of Brooks' centrifugal pumps of which they are exclusive agents. R. E. Spencer Geare will be the sales manager.

—The Mathieson Alkali Works, Saltville, Va., will use producer gas in their soda ash works. Contract for the producers and the engineering work has been let to the Morgan Construction Co., New York.

—Among the many attractive exhibits at the Portland Fair there is none that is attracting as wide attention as that of the Broderick & Bascom Rope Co., St. Louis, in the Manufacturers' Building. A very interesting feature of the exhibit is the carving set made entirely from steel rope.

—The National Tube Co. has placed a large and important order, for immediate execution, with the American Blower Co., Detroit. The contract embraces complete heating equipment for their five new Butt Weld Mills at Lorain.

—D. T. Williams Valve Co., Cincinnati, announce that they have just made arrangements for the exclusive manufacture and sale of the Cookson steam trap and separator. They have purchased the patents, patterns and good will of Thomas J. Cookson.

—The largest economizer in the New England States has just been installed by the B. F. Sturtevant Co., Boston, for the American Woolen Co., Maynard, Mass. It is divided into two groups, the first being used for heating feed water for the boilers and the second for furnishing hot water for dyeing purposes.

—The S. Obermayer Co., manufacturers of foundry facings and supplies, of Cincinnati, Chicago and Pittsburg, announce they have opened an office at 120 Liberty Street, New York. Edgar G. Seaman, who has represented the company at Pittsburg for many years past, has charge of the New York office.

—Whitcomb Manufacturing Co., J. Blaisdell & Co., and the Whitcomb Foundry Co., have united interests under the name of Whitcomb-Blaisdell Machine Tool Co., with main offices located at 134 Gold Street, Worcester. The several lines of metal planers, engine lathes, upright drills and machinery castings will be continued.

—The Ingersoll-Rand Co. took possession of its new offices on the fourteenth floor of the Bowling Green Building, 11 Broadway, New York, on August 1st. At that time the offices of the Ingersoll-Sergeant Drill Co., 26 Cortlandt Street, and the Rand Drill Co., 128 Broadway, were given up and the united forces moved to the new offices.

—A decided novelty in the way of an economizer installation is that now being made by the B. F. Sturtevant Co., Boston, for the American Steel & Wire Co., Consolidated Works, Cleveland. This equipment of 5,000 horse-power capacity to be used in connection with billet heating furnaces, is the first installation of this kind ever made in America.

—New York Continental Jewell Filtration Co., New York, report the following list of sales of filters: Home Brewing Co., Richmond, Va.; State Hospital for Insane, Danville, Pa.; Wilson Laundry Machinery Co., Columbia, Pa.; Dr. Thomas Kelly, Deal, N. J.; E. J. Garretson, Paterson, N. J., and Camm Brothers, Lynchburg, Va.

—The Wood Drill Works, Paterson, N. J., made a large shipment of their new well-known rock drills to France, and sent another lot to Sweden, and also sent a lot of their handy little 2¼-in. bull dog drills to Chile. Business is improving with them and they are now contemplating the erection of a two-story addition to their present structure to accommodate their increasing demands.

—The Pelton Water Wheel Co., San Francisco and New York, has just closed contract for a water wheel installation for D. J. Aguirre & Co., Tepic, Mexico. The head available is 175′, and the plant consists of two Pelton wheel units of 700 horse-power capacity each, direct connected to 300 revolutions per minute General Electric generators, also two Pelton wheel units for driving exciters. Sturgess oil type governors will be used.

—B. F. Sturtevant Co., Boston, has closed the following contracts for heating and ventilating apparatus; De Witt Clinton High School, New York; the Three Rivers High School, Three Rivers, Mich.; the Crescent High School, Louisville; the Plainfield High School, Plainfield, N. J.; John P. Squires & Co., box factory, Somerville, Mass.; American Pulley Co.'s plant, Philadelphia; the new Fort Pitt Hotel, Pittsburg; and the Fortune Brothers Brewing Co., Chicago.

—Among the work that the Robins Conveying Belt Co., New York, now has on hand is the contract for additional belt conveyors for the Chicago Fast Plant of the Semet Solvay Co.; an order for the mast and gaff rig and belt conveyors for the New York Contracting & Trucking Co., for use in excavating work at the Pennsylvania R. R. Station, New York, and the contract for a belt conveyor to be used by F. N. Stillman & Co., Jersey City, in connection with some large excavating work which they now have on hand.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Blowing Engines.

SOUTHWARK FOUNDRY AND MACHINE CO., Philadelphia.—Catalogue illustrating and describing the Southwark blowing engines and the many uses to which they may be adapted. Contains list of users. 9 by 6 in., pp. 48.

Chains.

LINK-BELT ENGINEERING CO., Philadelphia—Booklet No. 54 beautifully illustrated, tersely describing the advantages of the Renold roller chain. Contains tables giving prices, sizes, etc. 6 by 9 in.; pp. 14.

Coal Cutters.

INGERSOLL-SERGEANT DRILL CO., New York.—Catalogue illustrating and describing the construction and operation of the Radialax coal cutter. 6 by 9 in., pp. 20.

Also a pamphlet treating of the Haeseler axial valve hammers. 6 by 9 in., pp. 20.

Concentrators.

ALLIS-CHALMERS CO., Milwaukee—Catalogue No. 141 illustrating and describing the Overstrom table for concentrating ores and recovering values from tailings and slimes. 8 by 10½ in.; pp. 24.

Concrete Mixers.

RANSOME CONCRETE MACHINERY CO., New York.—Booklet illustrating and describing the 1905 model concrete mixers specially adapted for export. Also contains table giving weights, dimensions, and capacities. 3½ by 6 in.; pp. 24.

MUNICIPAL ENGINEERING AND CONTRACTING CO., Chicago.—Booklet illustrating and describing the Chicago improved cube concrete mixer. Also contains information of a reliable kind about cement and concrete work in general. 6 by 9 in.; pp. 32.

Dynamos and Motors.

NORTHERN ELECTRICAL MANUFACTURING CO., Madison, Wis.—Bulletin No. 50, describing standard dynamos and motors and the modifications of these frames. This bulletin illustrates Northern machines and their application in industrial plant service and machine shop work. 7 by 10 in., pp. 24.

Bulletin No. 48, containing illustration and description of the Northern standard emery grinders and buffing lathes. They are equipped with speed regulating devices so that the speed of the grinding and buffing wheels can be varied to compensate for the varying diameters of the wheels. 6½ by 10 in.; pp. 16.

Exhaust Fans.

AMERICAN BLOWER CO., Detroit.—Catalogue No. 180, treating of exhaust fans for the removal and conveying of shavings and dust, removal of smoke and fumes, and for use in connection with special heating and drying plants. Contains numerous illustrations. 7 by 8½ in., pp. 66. Also circular No. 66 illustrating and describing electric disc fans.

Feed-Water Heaters.

HARRISON SAFETY BOILER WORKS, Philadelphia.—Catalogue No. 20, containing an illustrated description of the Cochrane heaters for heating and purifying water for boiler feed and other purposes. Cochrane separators are also illustrated and described. 6 by 7¾ in. pp. 84.

Gas Producers.

MORGAN CONSTRUCTION CO., New York.—Well prepared catalogue containing much instructive information about their gas producer which heretofore has not been available to the public. On the embossed cover is mounted a half-tone of the producer printed in colors showing the correct condition of the fire. Also contains numerous illustrations. 6 by 9 in., pp. 50.

Grinding Machines.

CINCINNATI MILLING MACHINE CO., Cincinnati,—Catalogue containing a treatise on tool room grinding and grinding machines, giving considerable information on the subject of cutter and tool grinding. The numerous illustrations show how the work is handled, and the descriptions in connection with them contain much valuable data on cutter grinding. 6 by 9 in.; pp. 92.

Hardware Specialties.

WILCOX MANUFACTURING CO., Aurora, Ill.—General catalogue No. 6, illustrating and describing briefly the entire line of hardware specialties manufactured by them. The catalogue is arranged in sections—a section being devoted to house door hangers, barn door hangers and track, fire door hangers, rolling store ladders, etc. It is well printed and contains numerous illustrations. 6 by 9 in., pp. 158.

Indicators.

ASHCROFT MANUFACTURING CO., New York.—Pamphlet illustrating and describing the Tabor indicator. Contains tables giving dimensions, prices, etc. Indicator parts and supplies are also treated. 6 by 9 in.; pp. 32.

Locomotive Cranes.

BROWNING ENGINEERING CO., Cleveland.—Bulletin No. 19 contains numerous illustrations showing the Browning locomotive cranes at work. 6 by 9 in. pp. 28.

Manganese Steel Rails.

TAYLOR IRON & STEEL CO., High Bridge, N. J.—Pamphlet containing reprint of an article in the *Railroad Gazette*, March 17, 1905, giving the experience of the Boston Elevated Railway Co. in the use of rails of various compositions.

Mining Equipment.

WELLMAN-SEAVER-MORGAN CO., Cleveland.—Catalogue illustrating and describing mine cages, skips, ore cars, and sheaves. Tables giving dimensions, capacity, etc., are also included. 6 by 9 in.; pp. 40.

Mixers.

W. D. DUNNING, Syracuse.—Catalogue devoted to an illustrated description of the Broughton mixer for mixing sand, lime, paints, fertilizers, soap powder, baking powder, and

many other substances. Contains many testimonials from recent purchasers. 6 by 9 in., pp. 20.

Motors.

CROCKER-WHEELER CO., Ampere, N. J.—Bulletin No. 58, containing a reprint in abridged form of a series of articles on The Application of Individual Motor Drves to Old Machne Tools by Roy V. Wright, associate editor of the *American Engineer and Railroad Journal*, and which appeared in that paper. 7½ by 10 in.; pp. 32. Bulletin No. 53 treats of direct current lighting and power generators. Contains illustrations showing some recent installations. 7½ by 10 in.; pp. 16.

Motor Trucks.

BALDWIN LOCOMOTIVE WORKS, Philadelphia.—Catalogue containing record of recent construction of electric motor trucks for railway and interurban service, together with illustrations of the different types manufactured. 9 by 6 in., pp. 32.

Oiling Devices.

WM. H. WILKINSON CO., West Medway, Mass.—Catalogue illustrating and describing oiling devices and oil cups for engines and machinery. Contains tables giving capacities and prices of the different sizes of cups. 6 by 9 in., pp. 50.

Pumps.

KINGSFORD FOUNDRY AND MACHINE WORKS. Oswego, N. Y.—Booklet showing illustrations of a number of the many styles and sizes of pumps built by them. 3½ by 6½ in.; pp. 56.

Railway Construction.

J. G. WHITE & Co., New York.—"Interurban Railway Construction" is the title of an artistic bulletin issued by this Company illustrated with several interesting half-tone reproductions of various phases of interurban railway work as executed by them. 8 by 10 in., pp. 16.

Sash Lifting Apparatus.

BURNHAM-HITCHINS-PIERSON CO., New York.—Catalogue illustrating and describing their sash lifting apparatus. Also contains illustrations showing some recent installations. 8½ by 11 in., pp. 20.

Screens.

JEFFREY MANUFACTURING CO., Columbus.—Supplement to screen catalogue No. 69, containing illustrations, together with a very brief description of the many different styles of screens manufactured by them. 6 by 9 in. pp. 24.

Steam Engines.

BALL ENGINE CO., Erie, Pa.—Very neat booklet illustrating and describing their side crank single cylinder and Corliss engines. 6 by 3½ in., pp. 20.

THE B. F. STURTEVANT CO., Boston.—Bulletins 75 and 76, descriptive respectively of its vertical and horizontal centre crank engines. Each type is built in about twenty sizes. The horizontal type is entirely enclosed, provided with water-shed partition and equipped with forced lubrication. These engines were particularly designed for the direct-connected driving of generators.

Steam Specialties.

WARREN WEBSTER & Co., Camden, N. J.—Leaflet illustrating and describing Webster specialties—feed-water heaters and purifiers; separators, oil and steam; expansion joints; preference valves; nickel-plated gauges; water-seal motors; vacuum governors; sight glasses; traps; strainers; and receiving and storage tanks. 4 by 9 in.; pp. 16.

Steel Bars.

ROGERS-SHEAR CO., Warren, Pa.—Pamphlet containing an illustrated description of the universal steel bars for reinforced concrete. 7 by 5¼ in.; pp. 16.

Steel-Concrete Structures.

TUCKER & VINTON CORPORATION, New York.—Pamphlet containing reproductions from photographs of some representative steel-concrete structures built by this company. 5½ by 9 in.; pp. 20.

Time Stamps.

CALCULAGRAPH CO., New York.—"Get Out of the Rut" is the title of a little booklet printed in two colors on tinted paper describing briefly the many different ways the calculagraph can be of service to those who have to do with the keeping of time. 3½ by 6¼ in.; pp. 12.

Tin Plate.

AMERICAN SHEET & TIN PLATE CO., Pittsburg.—"From Underfoot to Overhead" is the title of a well-written pamphlet describing the many processes through which a piece of iron ore passes on its way from the mine to its place on the home of man. Contains many tables giving much valuable data. The pamphlet is profusely illustrated. 7½ by 5 in., pp. 64.

Valves.

WM. G. COATS, Newark.—Folders containing a brief description of the Waring steam pressure regulating and reducing valve. Also contains a list giving sizes and prices. Well illustrated.

AMERICAN STEAM GAUGE AND VALVE MANUFACTURING CO., Boston—Circular illustrating and describing the special features of the American special pop safety valve. 8½ by 11 in.; pp. 4.

GOLDEN-ANDERSON VALVE SPECIALTY CO., Pittsburg.—Three pamphlets containing an illustrated description of the different types of valves manufactured by them. Steam traps are also given a place.

ASHTON VALVE CO., Boston.—Catalogue No. 12 is devoted to an illustrated description of pop safety and relief valves. Pressure and vacuum gages and their other engine and boiler steam specialties are also treated. Contains numerous tables giving sizes, prices, etc., together with other information of a valuable nature. 6 by 9 in.; pp. 120.

Water Softening System.

WM. B. SCAIFE & SONS CO., Pittsburgh.—Booklet containing illustrations of a few of the many steam users who have installed the Scaife water softening and purifying system. 3½ by 6 in.; pp. 12.

Wattmeters.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., Pittsburg.—Small booklet containing an illustration and description of type B integrating wattmeters, 3½ by 6 in.; pp. 24.

FOR MEN WHO THINK

The news value of the advertising in modern engineering journals is becoming more and more apparent to a widening number of discerning readers. The reason for this is the inseparable relationship between the reading pages and the advertising in a periodical like The Engineering Magazine.

Our foremost manufacturers have long ago demonstrated that all the secrets of cheap production are to be found in labor-saving machinery and improved methods; and it is in the advertising pages that we find the sure record of this mechanical progress. For the advertisements deal with accomplished facts rather than theories--that is to say, they offer improved machines, devices, materials and methods of doing work, which are guaranteed to save money, increase output, and reduce the costs of production.

Much time and money have been spent in the preparation of the advertisements for this number of The Engineering Magazine, and dozens of them have been specially written for this issue. They cannot fail to repay a careful perusal; and a word of inquiry to the manufacturer of any machine, device or material advertised will bring to you, free of cost, industrial literature of unmistakable value.

2030

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UNIV. OF MICH.
SEP 11 1905

SEPTEMBER, 1905.
PRICE, 25 CTS

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THE ENGINEERING MAGAZINE

SPECIALLY DEVOTED TO THE INTERESTS OF

ENGINEERS, SUPERINTENDENTS & MANAGERS

THE PANAMA CANAL
BY JOHN F. WALLACE

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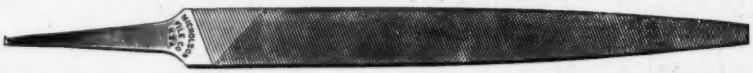

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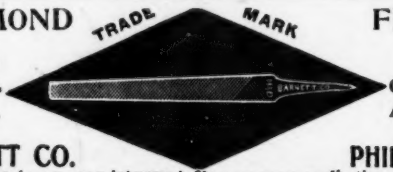

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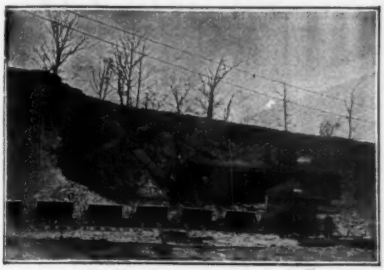

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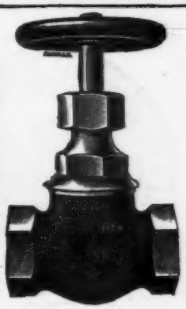

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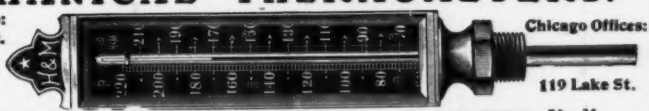

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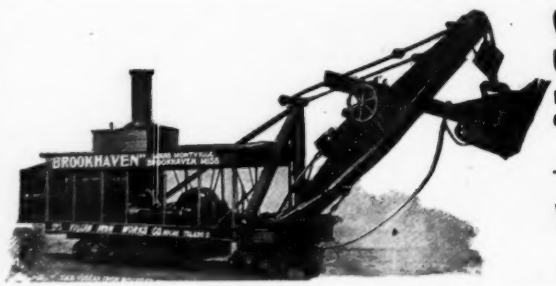

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AUTHORS AND PAPERS FOR SEPTEMBER 1905.

JOHN F. WALLACE (*The Actual Problems of the Panama Canal*)—Born in Fall River, Mass., Sept. 10, 1852; studied civil engineering at University of Wooster; began railway service in 1869 as rodman; assistant engineer of Rockford, Rock Island and St. Louis R. R. in 1870; assistant engineer U. S. Engineers in 1871; superintendent Peoria and Farmington R. R. 1879; chief engineer Central Iowa Railway, 1883; bridge engineer, Atchison, Topeka and Santa Fé, 1887, where he had charge of the construction of the Mo. River bridge; resident engineer, Chicago, Madison and Northern R. R., 1889; engineer, Central R. R., 1891-2; second vice-president, 1898-1901; assistant general manager, 1901-2; general manager, Ill. Central System, 1902; member and past president of Society of Civil Engineers Great Britain; member Am. Society of Civil Engineers; member and past president Am. Railway Engineering and Maintenance of Way Association; appointed chief engineer of the Isthmian Canal Commission in 1904.

FRANZ KOESTER (*Modern Power-Plant Design and Economics*)—Born in Sterkrade, Rhineland, the industrial center of Germany; at the age of 14, began engineering work at the foundation by entering the shops, part of his experience at this time being in construction; had three years' technical training and served a short time in the army; then took up again the profession of engineering, in the construction office of a general engineering concern; in 1899 entered the service of the Schuckert Company, Nuremberg, in the department of power-plant design, being connected also to some extent with railway work; during the three years he remained with this company he was intimately identified with the work on a number of plants, both steam and water-power, installed in Europe, Asia, and South and Central America; in 1902 removed to the United States and entered the mechanical engineering department of the Interborough Company, New York, where he is still engaged; a well-known contributor to the technical press on the generation, distribution, and utilization of power and on electric traction.

CHAS. ALBERTSON (*The Dock-Yards and Shipbuilding Plant of Japan*)—Member Am. Society Civil Engineers; member Engineers' Club of Philadelphia. Born 1869; degree of civil engineer from Lafayette College in 1893; eighteen months mechanical engineer in slate quarries at Bangor, Pa.; college vocations, railroad engineering, and general surveying 1894-5; assistant in mechanical engineering with the Ingersoll-Sergeant Drill Co. in charge of design and testing; 1896-7, engaged in important work in chief engineer's office P. R. R.; in 1897 instructor in Columbia University; subsequently with the American Trading Co.; visited many manufacturing plants before going to Japan, where he traveled extensively and, in the practice of his profession, resided more than six years; a large share of his practice has been connected with dock-yards, ship-building yards, mills, shops, factories, etc.

WILLIAM M. BARR (*Hydraulic Generation and Application of Motive Power*)—A Pennsylvanian by birth; entered the Engineering Corps of the U. S. Navy during the Civil War; resigned several years later by reason of severe illness contracted during service on the Isthmus of Panama. Designed the engines and started the methods employed by the Atlas Engine Works, Indianapolis, Ind.; afterwards superintendent of Henry R. Worthington, Hydraulic Works, New York; organized the Barr Pumping Engine Co., Philadelphia; upon the breaking out of the Spanish-American War, he was assigned to duty at League Island Navy Yard, and afterwards transferred to Boston Navy Yard. Mr. Barr is now the director of the New York School of Technology.

WALTER B. SNOW (*Working Examples of Successful Stores Management*)—Born, Watertown, Mass., 1860; graduate Mass. Inst. Tech., 1882; assistant in mechanical engineering, Mass. Inst. Tech., 1882-3; one year in shops of Geo. F. Blake Mfg. Co., Boston; for twenty years with B. F. Sturtevant Co., Boston, in various positions. Writer and lecturer upon fan-blower practice; author of "Mechanical Draft" and "Steam Boiler Practice"; member American Society of Mechanical Engineers, etc.

R. V. NORRIS (*A Discussion of Methods of Mine Hoisting*)—Educated at the Collegiate School and Columbia University, N. Y. (E.M., 1885); assistant to Prof. Munroe, summer schools of mining and surveying, 1885; 1886, chemist with Herman Behr, and later assistant engineer Susquehanna Coal Co., Wilkes-Barré; 1893, principal assistant engineer, and 1900, chief engineer, Coal and Water Com-

panies of the Penna. Railroad; 1904, consulting engineer to same companies, and in general consulting practice at Wilkes-Barré; specialities, coal mining and preparation, mining machinery (especially hoisting, pumping and ventilation) and examination of coal lands and water supply and distribution; member of American Societies of Civil and of Mechanical Engineers and American Institute of Mining Engineers, and a contributor of many papers to their proceedings and to technical periodicals.

O. M. BECKER (*High Speed Steel in the Factory*)—Born on a farm, some thirty-six years ago; elementary education received in district and village schools; graduated from college after reaching manhood, in 1897; supported family of four while in school, and finished course in much less than usual time; always inclined toward science and mechanics; teacher in district schools and principal in villages; after graduation, assistant in science laboratories, Kansas State Normal School; later City Supt. of schools in small cities, and conductor of teachers' institutes; came to Chicago in 1901 to study industrial-social conditions at first hand; soon afterward entered the employ of the International Harvester Company, where investigations were undertaken looking toward securing greater productive efficiency and bettering working conditions; became interested in the development of the new tool steels; more recently Supt. of McCormick Technical School, an effort to solve the problem of factory education; in consulting practice, taking up especially the welfare and altruistic side of manufacturing; in demand as a lecturer on this and other subjects.

WALTER BROWN (*High Speed Steel in the Factory*)—Born in Barrow-in-Furness, England, Mar. 9, 1879; came to America in 1886; grammar school education; four years apprentice with Fraser & Chalmers, covering the work of moulding, patternmaking, machinist, and drafting; recent years devoted to following up mechanical engineering; employed, usually in designing or perfecting machine tools, by Siemens & Halske, Western Electric Co., U. S. Arsenal at Rock Island, and lately by the International Harvesting Company at their McCormick Works; at the latter place was tool steel expert, testing and designing new tools, especially with reference to the enlarged use of high speed steels; now with the Firth Stirling Steel Co., headquarters at Chicago.

JOHN P. COWING (*Cost-Keeping in Construction and Contract Work*)—A contracting engineer, practicing in Cleveland, Ohio; designer of lift bridges, turntables, and structural steel work, including reinforced-concrete construction and structures of special design. His experience in the design and administration of engineering work of this character has given him especial opportunities for devising effective and complete methods of keeping the necessary cost records, which methods are embodied in his contribution to this issue of the Magazine.

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The unseen loss is the greatest drain on any manufacturing business. It may take the form of

unnecessary fixed charges
waste of time
waste of material
useless men
useless records and methods
interruptions
unnecessary overtime
too many handlings
etc., etc., etc.

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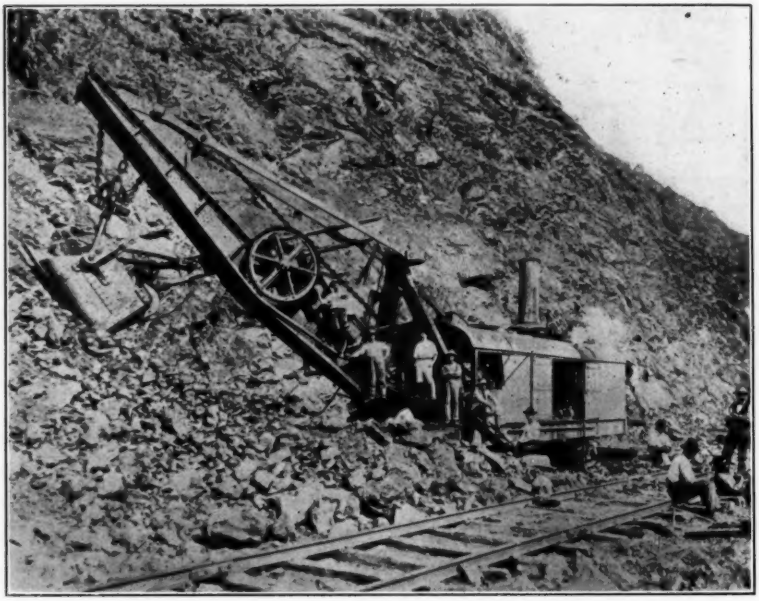

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Gunn, Richards & Co., New York.

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Burroughs Adding Mch. Co., Detroit.

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Henry R. Worthington, New York.

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General Compressed Air Co., St. Louis.

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Chicago Pneu. Tool Co., Chicago.
Clayton Air Compressor Works, N. Y.
Ingersoll-Sergeant Drill Co., N. Y.

Air Hoists.
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Chicago Pneu. Tool Co., Chicago.
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Wallace Supply Co., Chicago.

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Elec. Controller & Supply Co., Cleveland.
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Ransome Concrete Mchy. Co., New York.

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John H. McGowan Co., Cincinnati.
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Am. Hoist & Derrick Co., St. Paul.

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J. G. White & Co., New York.

Contractors' Supplies.
Am. Hoist & Derrick Co., St. Paul.
Broderick & Bascom Rope Co., St. Louis.
R. B. Lawrence, New York.

Controllers.
Elec. Controller & Supply Co., Cleveland.

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Conveying Machinery.
Broderick & Bascom Rope Co., St. Louis.
Browning Eng'g Co., Cleveland.
H. W. Caldwell & Sons Co., Chicago.
Frick Co., Waynesboro, Pa.
Cortlandt St. Iron Wks., Jersey City.
Hayward Co., New York.
C. W. Hunt Co., New York.
Interstate Eng'g Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel, New York.
Lidgerwood Mfg. Co., New York.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Trenton Iron Co., Trenton, N. J.
Webster Mfg. Co., Chicago.
Wellman-Seaver-Morgan Co., Cleveland.

Cooling Towers.
Alberger Condenser Co., New York.
George Stocker, St. Louis.
Henry R. Worthington, New York.

Corrugating Machinery.
Erie Foundry Co., Erie, Pa.

Corporation Counselors.
Everett Audit Co., Chicago.

Cost Systems.
Audit Co., of N. Y., New York.
Baker-Vawter Co., Chicago.
Everett Audit Co., Chicago.
Gunn, Richards & Co., New York.

Cotton Oil Machinery.
Laidlaw-Dunn-Gordon Co., New York.
Platt Iron Works, Dayton, Ohio.
Union Steam Pump Co., Battle Creek.

Couplings.
Almond Mfg. Co., Brooklyn.
Am. Steel Foundries, New York.
Broderick & Bascom Rope Co., St. Louis.

Cranes.
Am. Hoist & Derrick Co., St. Paul.
Browning Eng'g Co., Cleveland.
Case Mfg. Co., Columbus.
Hayward Co., New York.
Industrial Works, Bay City, Mich.
Interstate Eng'g Co., Cleveland.
Niles-Bement-Pond Co., New York
Pedrick & Ayer Co., Plainfield, N. J.
Riter-Conley Mfg. Co., Pittsburg.
Wellman-Seaver-Morgan Co., Cleveland.
R. D. Wood & Co., Phila.

Crucibles.
Jos. Dixon Crucible Co., Jersey City.
S. Obermayer Co., Cincinnati.
J. D. Smith Fdy. Supply Co., Cleveland.

Crusher, Ore, Phosphate, Rock.
Allis-Chalmers Co., Chicago.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.
F. L. Smidth & Co., New York.
Sturtevant Mill Co., Boston.
Wellman-Seaver-Morgan Co., Cleveland.

Cupolas.
S. Obermayer Co., Cincinnati.
J. D. Smith Fdy. Supply Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.

Cutters, Milling.
Becker-Brainard Mill. Mch. Co., Hyde Park, Mass.
Standard Tool Co., Cleveland.

Dams, Steel Concrete.
Ambursen Hydraulic Cons. Co., Boston.

Derricks and Fittings.
Am. Hoist & Derick Co., St. Paul.
Contractors' Plant Mfg. Co., Buffalo.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Doublers.
Erie Foundry Co., Erie, Pa.

Draft, Mechanical.
B. F. Sturtevant Co., Hdye Park, Mass.

Drilling Machines.
Am. Tool Wks. Co., Cincinnati.
W. F. & J. Barnes Co., Rockford, Ill.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.
Chicago Pneu. Tool Co., Chicago.
Jas. Clark, Jr., & Co., Louisville.
Cleveland Pneu. Tool Co., Cleveland.
Thos. H. Dallett Co., Phila.
Hisey-Wolf Mch. Co., Cincinnati.
Pratt & Whitney Co., Hartford.
William Sellers Co., Inc., Phila.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Drills—Rock and Coal.
Am. Diamond Rock Drill Co., New York.
Chicago Pneumatic Tool Co., Chicago.
Clayton Air Compress Wks., N. Y.
Hall Steam Pump Co., Pittsburg.
Ingersoll-Sergeant Drill Co., N. Y.
Jeffrey Mfg. Co., Columbus.
Rand Drill Co., New York.
Wood Drill Co., Paterson, N. J.

Drop Forgings.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Wyman & Gordon, Worcester, Mass.

Drop Hammers.
Erie Foundry Co., Erie, Pa.

Drying Apparatus.
B. F. Sturtevant Co., Hdye Park, Mass.

Dump Cars.
Western Wheel Scraper Co., Aurora, Ill.

Dynamos.
Am. Engine Co., Bound Brook, N. J.
Bullock Elec. Mfg. Co., Cincinnati.
Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., New York.
General Electric Co., New York.
Guarantee Electric Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, O.
Sprague Electric Co., New York.
B. F. Sturtevant Co., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Elbows, Pipe.
Whitlock Coil Pipe Co., Hartford.

Electric Heating Apparatus.
Simplex Elec. Heating Co., Cambridgeport, Mass.

Electric Hoists.
Am. Hoist & Derrick Co., St. Paul.
Browning Eng'g Co., Cleveland.
C & C Electric Co., New York.
C. W. Hunt Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., Boston.
Niles-Bement-Pond Co., New York.
Sprague Electric Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.

Electric Lighting Apparatus.
Gen. Railway Supply Co., Pittsburg.

Elec. Welding Outfits.
C & C Electric Co., New York.

Electric Signs.
Haller Machine Co., Chicago.

Electrical Laboratory Furnaces.
Charles Engelhard, New York.

Elevators.
Am. Tool & Mch. Co., Boston.
H. W. Caldwell & Sons Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
S. Obermayer Co., Cincinnati.
Poole Eng'g & Mch. Co., Baltimore.

Emery Wheels.
Carborundum Co., Niagara Falls.
Frank Machinery Co., Buffalo.
Stow Flexible Shaft Co., Phila.

Engineering Instruments.
Theo. Alteneder & Sons, Phila.
Bandis Sons Co., Brooklyn.
Buff & Buff Mfg. Co., Boston.
Eugene Dietzgen Co., Chicago.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Queen & Co., Phila.

Engineers.
Arnold Co., Chicago.
Wm. M. Brewer, Vancouver, B. C.
George M. Brill, Los Angeles.
Abner Doble Co., San Francisco.
Dodge & Day, Philadelphia.
Gunn, Richards & Co., New York.
Hudson Eng. & Cont. Co., New York.
Robt. W. Hunt & Co., Chicago.
D. C. & W. B. Jackson, Madison.
Julian Kennedy, Pittsburg.
Walter Kennedy, Pittsburg.
G. W. McClure, Son & Co., Pittsburg.
W. S. Palmer, Kansas City.
Power Installation Co., Buffalo.
Thomas Pray, Jr., Boston.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, New York.
H. Von Schon, Detroit.
Wellman-Seaver-Morgan Co., Cleveland.
J. G. White & Co., New York.

Engines, Blowing.
Allis-Chalmers Co., Chicago.
American Blower Co., Detroit.
Platt Iron Works, Dayton, Ohio.
Southwark Fdy. & Mch. Co., Phila.
Sprague Elec. Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.

Engines, Marine.
Atlantic Works, East Boston, Mass.
Moran Bros., Seattle, Wash.
Vulcan Iron Wks. Co., Toledo.

Engines—Gas and Gasoline.
Ajax Iron Works, Corry, Pa.
American Well Works, Aurora, Ill.
Foos Gas Eng. Co., Springfield, O.
Snow Steam Pump Wks., New York.
Struthers-Wells Co., Warren, Pa.
Titusville Iron Co., New York.
Westinghouse Mch. Co., Pittsburg.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse, Church, Kerr & Co., New York.

Engines, Steam.
Ajax Iron Works, Corry, Pa.
Allis-Chalmers Co., Chicago.
American Blower Co., Detroit.
Am. Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Atlas Engine Works, Indianapolis.
Ball Engine Co., Erie, Pa.
Geo. F. Blake Mfg. Co., New York.
Frick Co., Waynesboro, Pa.
Hooven, Owens, Rentschler Co., Hamilton.
P. B. McCabe & Co., Los Angeles.
Mecklenburg Iron Wks., Charlotte, N. C.
Providence Eng'g Wks., Providence.
Reeves Engine Co., New York.
Shepherd Eng'g Co., Franklin, Pa.
Southwark Fdy. & Mch. Co., Phila.
Struthers-Wells Co., Warren, Pa.
B. F. Sturtevant Co., Hyde Park, Mass.
Titusville Iron Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse Mch. Co., Pittsburg.
Westinghouse, Church, Kerr & Co., New York.
Robt. Wetherill & Co., Chester, Pa.

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Evaporators.
Geo. F. Blake Mfg. Co., New York.
Knowles Steam Pump Wks., N. Y.

Excavators.
Am. Hoist & Derrick Co., St. Paul.
Atlantic, Gulf & Pacific Co., N. Y.
Broderick & Bascom Rope Co., St. Louis.
Bucyrus Co., So. Milwaukee, Wis.
Hayward Co., New York.
Jeffrey Mfg. Co., Columbus.
Marion Steam Shovel Co., Marion, O.
Municipal Engineering & Contracting Co., Chicago.
Robins Conveying Belt Co., N. Y.
Vulcan Iron Wks., Toledo.

Exhaust Heads.
Am. Spiral Pipe Wks., Chicago.
Direct Separator Co., Syracuse.
Hoppes Mfg. Co., Springfield, O.
Pittsburg Gage & Supply Co., Pittsburg.
B. F. Sturtevant Co., Hyde Park, Mass.
Watson & McDaniel Co., Phila.
Wright Mfg. Co., Detroit.

Expanded Metal.
Associated Expanded Metal Cos., New York.

Eye Benders.
Wallace Supply Co., Chicago.

Fans, Ventilating.
Allis-Chalmers Co., Chicago.
American Blower Co., Detroit.
Green Fuel Economizer Co., Mattea-wan, N. Y.
Power-Specialty Co., New York.
Sprague Electric Co., New York.
B. F. Sturtevant Co., Hyde Park, Mass.

Feed-Water Heaters and Purifiers.
Allis-Chalmers Co., Chicago.
Geo. F. Blake Mfg. Co., New York.
Goubert Mfg. Co., New York.
Green Fuel Economizer Co., Mattea-wan, N. Y.
Harrison Safety Boiler Wks., Phila.
Knowles Steam Pump Wks., N. Y.
Hoppes Mfg. Co., Springfield, O.
John H. McGowan Co., Cincinnati.
National Pipe Bend. Co., New Haven.
Platt Iron Works Co., Dayton.
Providence Eng'g Wks., Providence.
Ross Valve Co., Troy.
Wm. B. Scaife & Sons Co., Pittsburg.
Stewart Heater Co., Buffalo.
Warren Webster & Co., Camden, N. J.
Whitlock Coil Pipe Co., Hartford.
Robt. Wetherill & Co., Chester, Pa.
Henry R. Worthington, New York.

Felt, Waterproof.
Hydrex Felt & Eng'g Co., New York.

Files and Rasps.
G. & H. Barnett Co., Phila.
Nicholson File Co., Providence.

Filters.
L. O. Koven & Bro., New York.
N. Y. Cont. Jewell Filt. Co., N. Y.
Ross Valve Co., Troy.
Wm. B. Scaife & Sons Co., Pittsburg.
Robt. Wetherill & Co., Chester, Pa.

Fire Box Blocks.
McLeod & Henry Co., Troy, N. Y.

Fire Brick.
Henry Maurer & Son, New York.
National Pyrogranit Co., New York.
S. Obermayer Co., Cincinnati.
J. D. Smith Fdy. Supply Co., Cleveland.

Fireproof Building Materials.
Clinton Fireproofing System, N. Y.
Henry Maurer & Son, New York.
Roebling Construction Co., New York.

Flanges.
Am. Spiral Pipe Wks., Chicago.
E. M. Dart Mfg. Co., Providence.

Flexible Shafts.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Flexible Steel Tubing.
Almond Mfg. Co., Brooklyn.

Float Valves.
Foster Eng'g Co., Newark.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland.

Fly Wheels.
Allis-Chalmers Co., Chicago.
Poole Eng'g & Mch. Co., Baltimore.
Robt. Wetherill & Co., Chester, Pa.

Forges.
B. F. Sturtevant Co., Hyde Park, Mass.

Forgings, Iron and Steel.
Chester B. Albree, Allegheny, Pa.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Vulcan Iron Wks. Co., Toledo.
Wyman & Gordon, Worcester.

Foundry Improvements.
Goldschmidt Thermit Co., New York.

Foundry Equipment.
Am. Air Compressor Wks., New York.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.
Geo. F. Blake Mfg. Co., New York.
Buffalo Foundry Co., Buffalo.
Globe Mch. & Stamping Co., Cleveland.
C. W. Hunt Co., New York.
Ingersoll-Sergeant Drill Co., N. Y.
Arthur Koppel, New York.
S. Obermayer Co., Cincinnati.
Pedrick & Ayer Co., Plainfield, N. J.
J. D. Smith Fdy. Supply Co., Cleveland.
Wellman-Seaver-Morgan Co., Cleveland.

Friction Clutches.
Am. Tool & Mch. Co., Boston.
H. W. Caldwell & Sons Co., Chicago.
Elec. Controller & Supply Co., Cleveland.
Link-Belt Eng'g Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.
Sinclair-Scott Co., Baltimore.

Fuel Economizers.
Green Fuel Economizer Co., Mattea-wan, N. Y.
Providence Eng'g Wks., Providence.
B. F. Sturtevant Co., Hyde Park, Mass.

Furnace Builders.
Am. Gas Furnace Co., New York.
Continental Iron Wks., Brooklyn.
Julian Kennedy, Pittsburg.
G. W. McClure, Son & Co., Pittsburg.
Morgan Const. Co., Worcester.
Riter-Conley Mfg. Co., Pittsburg.
Wellman-Seaver-Morgan Co., Cleveland.

Gages — Pressure, Steam, Water.
Am. Steam Gauge & Valve Co., Boston
Ashton Valve Co., Boston.
Wm. T. Bonner Co., Boston.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston.
Hohmann & Maurer Mfg. Co., Rochester.
Manning, Maxwell & Moore, N. Y.
Pittsburg Gage & Supply Co., Pittsburg.
John Simmons Co., New York.
Star Brass Mfg. Co., Boston.
Walworth Mfg. Co., Boston.

Galvanizing.
L. O. Koven & Bro., New York.
John Simmons Co., New York.

Galvanizing Machinery.
Erie Foundry Co., Erie, Pa.

Gas Machines & Generators.
Am. Gas Furnace Co., New York.
Link-Belt Eng'g Co., Phila.
Morgan Const. Co., Worcester.
R. D. Wood & Co., Phila.
Walworth Mfg. Co., Boston.

Gas Blowers and Exhausters.
B. F. Sturtevant Co., Hyde Park, Mass.

Gaskets.
Am. Spiral Pipe Wks., Chicago.
Boston Belting Co., Boston.

Gear Cutting Machines.
Becker-Brainard Mill. Mch. Co., Hyde Park, Mass.

Gearing.
Allis-Chalmers Co., Chicago.
Hugo Bilgram, Phila.
Geo. F. Blake Mfg. Co., New York.
Wm. Ganschow, Chicago.
Gen. Railway Supply Co., Pittsburg.
Boston Gear Works, Boston.
H. W. Caldwell & Son Co., Chicago.
D. O. James, Chicago.
Jeffrey Mfg. Co., Columbus.
New Process Rawhide Co., Syracuse.
R. D. Nuttall Co., Pittsburg.
Poole Eng'g & Mch. Co., Baltimore.
Wm. Sellers Co., Inc., Phila.
Stow Flexible Shaft Co., Phila.
Robt. Wetherill & Co., Chester, Pa.

Generating Sets.
B. F. Sturtevant Co., Hyde Park, Mass.

Gold Dredging Machinery.
Jos. Dixon Crucible Co., Jersey City.
S. Obermayer Co., Cincinnati.
Risdon Iron Works, San Francisco.

Graphite.
J. D. Smith Fdy. Supply Co., Cleveland.

Grates, Traveling Link.
Green Engineering Co., Chicago.

Grease Separators.
Loew Supply & Mfg. Co., Cleveland.

Grinding & Polishing Mchy.
American Tool Wks. Co., Cincinnati.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Jas. Clarke, Jr., & Co., Louisville.
Crocker-Wheeler Co., Ampere, N. J.
Erie Foundry Co., Erie, Pa.
Hisey-Wolf Mch. Co., Cincinnati.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison.
Pratt & Whitney Co., Hartford.
F. L. Smidth & Co., New York.
Stow Flexible Shaft Co., Phila.
Williams Elec. Mch. Co., Akron.
William Sellers Co., Inc., Phila.

Hammers, Electric.
Northern Elec. Mfg. Co., Madison, Wis.

Hammers and Shears.
Erie Foundry Co., Erie, Pa.

Hammers, Power.
Erie Foundry Co., Erie, Pa.

Hand Drill—Electric.
Hisey-Wolf Mch. Co., Cincinnati.

Heading & Upsetting Mchy.
National Mchy. Co., Tiffin, Ohio.

Heating and Ventilating Apparatus.
American Blower Co., Detroit.
Manning, Maxwell & Moore, N. Y.
John Simmons Co., New York.
Sprague Elec. Co., New York.
H. B. Smith Co., New York.
Stewart Heater Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Warren Webster & Co., Camden, N. J.

High Pressure Steel Fittings.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.

Hoisting Engines and Mchy.
Allis-Chalmers Co., Chicago.
Am. Hoist & Derrick Co., St. Paul.
Broderick & Bascom Rope Co., St. Louis.

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Brown Hoist. Mch. Co., New York.
Browning Eng'g Co., Cleveland.
Contractors' Plant Mfg. Co., Buffalo.
Gen. Pneu. Tool Co., Montour Falls, N. Y.
Hayward Co., New York.
C. W. Hunt Co., New York.
Industrial Wks., Bay City, Mich.
Interstate Eng'g Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Link-Belt Eng'g Co., Phila.
P. B. McCabe & Co., Los Angeles.
Mead-Morrison Mfg. Co., Boston.
Providence Eng'g Works, Providence.
William Sellers Co., Inc., Phila.
Sprague Elec. Co., New York.
Stuebner Iron Wks., Long Isld. City.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Wks. Co., Toledo.
Wellman-Seaver-Morgan Co., Cleveland.
Williams Elec. Mch. Co., Akron.

Hollow Concrete Building Block Machines.

Harmon S. Palmer Hollow Bldg. Block Co., Washington, D. C.

Hose.

Chicago Pneumatic Tool Co., Chicago.
Boston Belting Co., Boston.
Eureka Fire Hose Co., New York.

Hydraulic Machinery.

Dayton Hydraulic Mchy. Co., Dayton.
Erie Foundry Co., Erie, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Platt Iron Works, Dayton, Ohio.
Warren Steam Pump Co., Warren, Mass.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.

Hydraulic Rams.

Pelton Water Wheel Co., 'Frisco.
Power Specialty Co., New York.

Ice-Mak'g & Refriger. Mchy.

Frick Co., Waynesboro, Pa.
H. B. Roelker, New York.

Index Centers.

Stockbridge Machine Co., Worcester.

Indicators.

John S. Bushnell & Co., New York.

Injectors.

Hayden & Derby Mfg. Co., N. Y.
John Simmons Co., New York.

Internal Gearing.

Wm. Ganschow, Chicago.
R. D. Nuttall Co., Pittsburg.

Iron and Bronze, Ornamental.

W. S. Tyler Co., Cleveland.

Iron, Yorkshire.

B. M. Jones & Co., Boston.

Jacks, Hydraulic.

Watson-Stillman Co., New York.

Knife Grinding Machinery.

Erie Foundry Co., Erie, Pa.

Lamps, Electric.

General Electric Co., New York.
Sawyer-Man Elec. Co., Pittsburg.
C. J. Toerring Co., Phila., Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Larries.

Mineral Ridge Mfg. Co., Mineral Ridge, O.

Lathes.

American Tool & Mch. Co., Boston.
American Tool Wks. Co., Cincinnati.
W. F. & J. Barnes Co., Rockford, Ill.
Bullard Mch. Tool Co., Bridgeport, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
F. E. Reed Co., Worcester, Mass.
Warner & Swasey, Cleveland.
William Sellers Co., Inc., Phila.

Lift Bridges.

John P. Cowing, Cleveland.

Lifting Magnets.

Elec. Controller & Supply Co., Cleveland.
Williams Elec. Mch. Co., Akron.

Light Railways.

C. W. Hunt Co., New York.
Arthur Koppel, New York.
Link-Belt Eng'g Co., Phila.
Stuebner Iron Wks., Long Isld. City.

Lockers.—Metal.

Merritt & Co., Phila.

Locomotive Axles.

B. M. Jones & Co., Boston.

Locomotive Cranes.

Amer. Hoist & Derrick Co., St. Paul.
Browning Eng'g Co., Cleveland.
Industrial Wks., Bay City, Mich.
Interstate Eng'g Co., Cleveland.
Mead-Morrison Mfg. Co., Boston.
Wellman-Seaver-Morgan Co., Cleveland.

Locomotives.

American Locomotive Co., New York.
Baldwin Locomotive Wks., Phila.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., New York.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel, New York.
H. K. Porter Co., Pittsburg.
Rogers Locomotive Works, Paterson.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Lubricants.

Jos. Dixon Crucible Co., Jersey City.

Lubricating & Oiling Devices.

E. M. Dart Mfg. Co., Providence.
Pittsburg Gage & Supply Co., Pittsburg.

Machinery Exhibits.

Bourse, Philadelphia.

Machinery, Second Hand.

Chicago House Wrecking Co., Chicago.

Machinists' Small Tools.

Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford.
William Sellers Co., Inc., Phila.
Standard Tool Co., Cleveland.

Measuring Tapes.

Lufkin Rule Co., Saginaw, Mich.

Metal Stampings.

National Tool & Stamping Co., Germantown, Phila.

Metals, Carbonless.

Goldschmidt Thermit Co., New York.

Meters, Electric.

General Electric Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Weston Elec. Inst. Co., Waverly Park, N. J.

Milling Machines.

Adams Co., Dubuque, Iowa.
American Tool Wks. Co., Cincinnati.
Becker-Brainard Mill. Mch. Co., Hyde Park, Mass.
Bullard Mch. Tool Co., Bridgeport, Conn.
Hess-Bright Co., Phila.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Mill Supplies.

Mineral Ridge Mfg. Co., Mineral Ridge, O.
Pittsburg Gage & Supply Co., Pittsburg.

Mine Cars.

Allis-Chalmers Co., Chicago.
C. W. Hunt Co., New York.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel, New York.
Wellman-Seaver-Morgan Co., Cleveland.

Mining Machinery.

Allis-Chalmers Co., Chicago.
Am. Diamond Rock Drill Co., N. Y.
Gen. Railway Supply Co., Pittsburg.
Geo. F. Blake Mfg. Co., New York.
Broderick & Bascom Rope Co., St. Louis.
Deane Steam Pump Co., New York.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.
General Electric Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Ingersoll-Sergeant Drill Co., N. Y.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Arthur Koppel, New York.
Laidlaw-Dunn-Gordon Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
John H. McGowan Co., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Wks., Charlotte, N. C.
Norwalk Iron Wks., So. Norwalk, Ct.
Platt Iron Works, Dayton, Ohio.
Power Specialty Co., New York.
Providence Eng'g Wks., Providence.
Rand Drill Co., New York.
Risdon Iron Works, San Francisco.
Robins Conveying Belt Co., N. Y.
F. L. Smidth & Co., New York.
Snow Steam Pump Wks., New York.
Trenton Iron Wks. Co., Trenton, N. J.
Union Steam Pump Co., Battle Creek, Mich.
Vulcan Iron Wks. Co., Toledo.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Wellman-Seaver-Morgan Co., Cleveland.
Henry R. Worthington, New York.

Motors, Electric.

Am. Engine Co., Bound Brook, N. J.
Bullock Elec. Mfg. Co., Cincinnati.
C & C Electric Co., New York.
Elec. Controller & Supply Co., Cleveland.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Elec. Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, O.
Sprague Electric Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Moulding Machines.

Geo. F. Blake Mfg. Co., New York.
Frank Mchy. Co., Buffalo.
S. Obermayer Co., Cincinnati.
Power Specialty Co., New York.
J. D. Smith Fdy. Supply Co., Cleveland.

Name Plates and Labels.

Am. Ry. Supply Co., New York.
Schwerdtle Stamp Co., Bridgeport.

Naphtha Gas Machines.

Am. Gas Furnace Co., New York.

Nut Tappers.

National Mchy. Co., Tiffin, Ohio.

Office Furniture.

Koller & Smith, New York.
Shaw-Walker Co., Chicago.

Oil Burners.

C. A. Hammel, Los Angeles.

Oil Filters.

Wm. T. Bonner Co., Boston.
Loew Supply & Mfg. Co., Cleveland.
Pittsburg Gage & Supply Co., Pittsburg.

Packing.

Wm. T. Bonner Co., Boston.
Boston Belting Co., Boston.
Broderick & Bascom Rope Co., St. Louis.
Jenkins Brothers, New York.
Mabbs Hyd. Pack. Co., Chicago.

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Paints and Varnishes.
Jos. Dixon Crucible Co., Jersey City.
Lowe Bros. Co., Dayton, Ohio.
Paraffine Paint Co., San Francisco.
Sterling Varnish Co., Pittsburg.

Paper-Mill Machinery.
Geo. F. Blake Mfg. Co., New York.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Robins Conveying Belt Co., N. Y.
Snow Steam Pump Wks., New York.
Henry R. Worthington, New York.

Patent Attorneys.
C. A. Dieterich, New York.
Everett E. Kent, Boston.
Edw. M. Weeks, Washington, D. C.
Evans, Wilkins & Co., Washington, D. C.

Patent Back Combustion Chamber Arch.
McLeod & Henry Co., Troy, N. Y.

Pattern-Makers' Machinery.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.
Pratt & Whitney Co., Hartford.
J. D. Smith Fdy. Supply Co., Cleveland.

Pattern Makers.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.

Penstocks.
Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.

Perforated Metal.
Allis-Chalmers Co., Chicago.
H. W. Caldwell & Sons Co., Chicago.
Hendrick Mfg. Co., Carbondale, Pa.

Phosphor Bronze.
Phosphor Bronze Smelt. Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.

Pile Drivers.
Am. Hoist & Derrick Co., St. Paul.
Bucyrus Co., So. Milwaukee.
Ingersoll-Sergeant Drill Co., N. Y.
Interstate Eng'g Co., Cleveland.
Vulcan Iron Works Co., Toledo.

Pipe.
Am. Spiral Pipe Wks., Chicago.
L. O. Koven & Bro., New York.
National Pipe Bend. Co., New Haven.
Pelton Water Wheel Co., 'Frisco.
Pittsburg Gage & Supply Co., Pittsburg.
John Simmons, New York.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe Bends.
National Pipe Bend. Co., New Haven.
Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe-Cutting and Threading Machines.
Cox & Sons Co., Bridgeton, N. J.
Curtis & Curtis Co., Bridgeport, Ct.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
John Simmons Co., New York.
Stoever Foundry & Mfg. Co., Myerstown, Pa.
Walworth Mfg. Co., Boston.
Williams Tool Co., Erie, Pa.

Pipe Fittings, Cast-Iron.
American Spiral Pipe Wks., Chicago.
Pelton Water Wheel Co., San Francisco.
Pittsburg Gage & Supply Co., Pittsburg.
John Simmons Co., New York.
Walworth Mfg. Co., Boston.

Piston Rods.
B. M. Jones & Co., Boston.

Planers.
Am. Tool Wks. Co., Cincinnati.
Frank Machinery Co., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Planing Mill Machinery.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.

Plug Drills.
Thos. H. Dallett Co., Phila.

Pneumatic Tools.
Am. Air Compress. Wks., N. Y.
Chicago Pneu. Tool Co., Chicago.
Clayton Air Compress. Wks., N. Y.
Cleveland Pneu. Tool Co., Cleveland.
Curtis & Co. Mfg. Co., St. Louis.
Ingersoll-Sergeant Drill Co., N. Y.
Rand Drill Co., New York.

Pop Safety Valves.
Am. Steam Gauge & Valve Co., Boston.
Ashton Valve Co., Boston.
Consolidated Safety Valve Co., N. Y.
Crosby Steam Gauge & Valve Co., Boston.
Star Brass Mfg. Co., Boston.

Portable Drilling Machines.
Hisey-Wolf Mch. Co., Cincinnati.

Portable Time Stamps.
Perry Time Stamping Co., Chicago.

Power Machinery, Steam or Water.
Wellman-Seaver-Morgan Co., Cleveland.

Power-Transmission Mchy.
Allis-Chalmers Co., Chicago.
Broderick & Bascom Rope Co., St. Louis.
H. W. Caldwell & Sons Co., Chicago.
Case Mfg. Co., Columbus.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Hayward Co., New York.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Wks., Charlotte, N. C.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Platt Iron Works Co., Dayton.
Robins Conveying Belt. Co., N. Y.
Sprague Electric Co., New York.
Webster Mfg. Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
R. D. Wood & Co., Phila.

Power Punches.
Erie Foundry Co., Erie, Pa.

Power Trucks and Wagons.
Garford Co., Elyria, Ohio.

Pressed Metal Cases.
National Tool & Stamping Co., Germantown, Phila.

Presses and Dies.
Curtis & Curtis Co., Bridgeport.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
R. D. Wood & Co., Phila.

Production Engineers.
Audit Co., of N. Y., New York.
Everett Audit Co., Chicago.
Gunn, Richards & Co., New York.

Prospecting Drills.
Am. Diamond Rock Drill Co., N. Y.
Am. Well Wks., Aurora, Ill.
Star Drilling Machine Co., Akron, O.
Wood Drill Co., Paterson, N. J.

Pulleys, Shafting & Hangers.
Allis-Chalmers Co., Chicago.
Am. Tool & Mch. Co., Boston.
H. W. Caldwell & Sons Co., Chicago.
Fay & Egan, Cincinnati.
Frank Machinery Co., Buffalo.
Jeffrey Mfg. Co., Columbus.
Niles Tool Works Co., New York.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., N. Y.
Sinclair-Scott Co., Baltimore.

Pump Governors.
Albany Steam Trap Co., Albany.

Pumps and Pumping Mchy.
Albany Steam Trap Co., Albany.
Alberger Condenser Co., New York.
Allegheny Foundry Co., Ltd., Warren, Pa.
Allis-Chalmers Co., Chicago.
American Well Wks., Aurora, Ill.
Ashcroft Mfg. Co., New York.
Geo. F. Blake Mfg. Co., New York.
Bucyrus Co., So. Milwaukee.
Cameron Steam Pump Wks., N. Y.
Clayton Air Compress. Wks., N. Y.
Dayton Hydraulic Mchy. Co., Dayton.
Deane Steam Pump Co., New York.
Epping-Carpenter Co., Pittsburg.
Flint & Walling Mfg. Co., Kendallville, Ind.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Hall Steam Pump Co., Pittsburg.
Holly Mfg. Co., New York.
Ingersoll-Sergeant Drill Co., N. Y.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Lawrence Pump & Eng. Co., Lawrence, Mass.
Luitwieler Pump. Eng. Co., Los Angeles.
John H. McGowan Co., Cincinnati.
Mecklenburg Iron Wks., Charlotte, N. C.
Morris Mch. Wks., Baldwinsville, N. Y.
Platt Iron Works Co., Dayton.
Providence Eng'g Wks., Providence.
Rand Drill Co., New York.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
Warren Steam Pump Co., Warren, Mass.
Watson-Stillman Co., New York.
Robt. Wetherill & Co., Chester, Pa.
R. D. Wood & Co., Phila.
Henry R. Worthington, New York.

Punching & Shearing Mchy.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Erie Foundry Co., Erie, Pa.
Morgan Const. Co., Worcester.
National Machinery Co., Tiffin, O.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.
R. D. Wood & Co., Phila.

Pyrometers.
Edward Brown, Philadelphia.
Charles Engelhard, New York.
Queen & Co., Philadelphia.

Quarrying Machinery.
Am. Hoist & Derrick Co., St. Paul.
Broderick & Bascom Rope Co., St. Louis.
Ingersoll-Sergeant Drill Co., N. Y.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
John H. McGowan Co., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Rand Drill Co., New York.
Robins Conveying Belt Co., N. Y.
Trenton Iron Co., Trenton.
Vulcan Iron Wks. Co., Toledo.

Quartz Laboratory Ware.
Charles Engelhard, New York.

Quartz Mercury Lamps.
Charles Engelhard, New York.

Racks—Machine Cut.
Wm. Ganschow, Chicago.
R. D. Nuttall Co., Pittsburg.

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Radiators.
John Simmons Co., New York.

Rail Braces.
Continuous Rail Joint Co., Newark.

Rail Joints.
Goldschmidt Thermit Co., New York.

Railroad Pumping Engine.
Luftwieler Pump. Eng. Co., Los Angeles.

Railway Castings and Forgings.
Am. Steel Foundries, New York.
B. M. Jones & Co., Boston.

Railway Shop Machinery.
Chester B. Albree, Allegheny, Pa.
Am. Tool Wks. Co., Cincinnati.
W. F. & J. Barnes Co., Rockford, Ill.
Clayton Air Compress. Wks., N. Y.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.
Ingersoll-Sergeant Drill Co., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Niles-Bement-Gordon Co., New York.
Norwalk Iron Wks., So. Norwalk, Ct.
Pedrick & Ayer Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.
H. B. Underwood & Co., Phila.
Watson-Stillman Co., New York.

Rawhide Gears.
New Process Raw Hide Co., Syracuse.

Rawhide Packing.
Mabbs Hydraulic Pack. Co., Chicago.

Reamers.
Chicago Pneumatic Tool Co., Chicago.
Standard Tool Co., Cleveland.

Record. Devices—Automatic.
Perry Time Stamp Co., Chicago.

Resistance Banks and Units.
Elec. Controller & Supply Co., Cleveland.

Rheostats.
Simplex Elec. Heat. Co., Cambridge, Mass.

Riveting Machines.
Chester B. Albree, Allegheny, Pa.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Cleveland Pneu. Tool Co., Cleveland.
Ingersoll-Sergeant Drill Co., N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Pedrick & Ayer Co., Plainfield, N. J.
Rand Drill Co., New York.
William Sellers Co., Inc., Phila.
R. D. Wood & Co., Phila.

Rivet-Making Machinery.
Ajax Mfg. Co., Cleveland.
National Machinery Co., Tiffin, O.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.

Road Making Machinery.
Vulcan Iron Works, Toledo.

Rock Breakers.
Allis-Chalmers Co., Chicago.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Sturtevant Mill Co., Boston.
Western Wheel Scraper Co., Aurora, Ill.

Rolling Mill Machinery.
Birdsboro Steel Fdy. & Mch. Co., Birdsboro, Pa.
Erie Foundry Co., Erie, Pa.
Morgan Const. Co., Worcester.
Niles-Bement-Pond Co., New York.
Poole Eng. & Mach. Co., Baltimore.
Wellman-Seaver-Morgan Co., Cleveland.
Robt. Wetherill & Co., Chester, Pa.

Roll Lathes.
Erie Foundry Co., Erie, Pa.

Roofing.
Barrett Mfg. Co., New York.
Paraffine Paint Co., San Francisco.

Roofing Paints and Varnish.
Lowe Bros. Co., Dayton, Ohio.
Paraffine Paint Co., San Francisco.

Roofing Tin.
American Sheet & Tin Plate Co., Pittsburg.

Rope Transmission.
Broderick & Bascom Rope Co., St. Louis.

Rubber Goods.
Boston Belting Co., Boston.
Jenkins Bros., New York.

Sand Mixers and Sifters.
S. Obermayer Co., Cincinnati.

Sash Operating Device.
Burnham-Hitchins-Pierson Co., New York.

Saw-Mill Machinery.
Allis-Chalmers Co., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.
Jeffrey Mfg. Co., Columbus.

Screens, Mining.
Allis-Chalmers Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Mineral Ridge Mfg. Co., Mineral Ridge, O.
Robins Conveying Belt Co., N. Y.
W. S. Tyler Co., Cleveland.

Screens, Rolled Slot.
W. S. Tyler Co., Cleveland.

Screw Machines.
Jones & Lamson Mch. Co., Springfield, Vt.
National-Acme Mfg. Co., Cleveland.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Second Hand Building Material.
Chicago House Wrecking Co., Chicago.

Second Hand Machinery.
Chicago House Wrecking Co., Chicago.

Separators, Steam and Oil.
Allis-Chalmers Co., Chicago.
American Tool & Mch. Co., Boston.
Austin Separator Co., Detroit.
John Davis Co., Chicago.
Julian D'Este Co., Boston.
Direct Separator Co., Syracuse.
Goubert Mfg. Co., New York.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield, O.
Loew Supply & Mfg. Co., Cleveland.
Potter Separator Co., Newburgh, N.Y.
Warren, Webster & Co., Camden, N.J.
Watson & McDaniel Co., Phila.

Shaft Couplings, Flexible.
Elec. Controller & Supply Co., Cleveland.

Shapers.
American Tool Wks. Co., Cincinnati.
Cincinnati Shaper Co., Cincinnati.
Frank Machinery Co., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Stockbridge Machine Co., Worcester.

Shutters (Fire).
Kinnear Mfg. Co., Columbus.

Signs, Electric.
Haller Machine Co., Chicago.

Skylights and Ventilators.
American Machinery Co., New York.

Special Machinery.
Allegheny Fdy. Co., Ltd., Warren, Pa.
Globe Mch. & Stamping Co., Cleveland.
P. H. Morris, Phila.
F. J. Nutting, Dayton, Ohio.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.

Speed Controllers.
Foster Engineering Co., Newark.

Speed Lathes.
Stockbridge Machine Co., Worcester.

Spike Machines.
National Machinery Co., Tiffin, Ohio.

Spiral Gears.
R. D. Nuttall Co., Pittsburg.

Springs.
Am. Steel Foundries, New York.

Stamps — Steel, Alphabets and Figures.
Schwerdtle Stamp Co., Bridgeport.

Stand Pipes.
Struthers-Wells Co., Warren, Pa.
Tippett & Wood, Phillipsburg, Pa.
Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.

Staybolt Iron.
B. M. Jones & Co., Boston.

Steam Engine Indicators.
Ed. Brown, 311 Walnut St., Phila.
Star Brass Mfg. Co., Boston.

Steam Hammers.
Erie Foundry Co., Erie, Pa.

Steam-Regulat'g Appliances.
Albany Steam Trap Co., Albany.
Am. Steam Gauge & Valve Co., Boston.
Ashcroft Mfg. Co., New York.
Wm. T. Bonner Co., Boston.
John S. Bushnell & Co., New York.
Wm. G. Coats, Newark, N. J.
Crane Co., Chicago.
Julian D'Este Co., Boston, Mass.
Foster Engineering Co., Newark.
Harrison Safety Boiler Wks., Phila.
Jenkins Bros., New York.
Pittsburg Gage & Supply Co., Pittsburg.
Power Specialty Co., New York.
John Simmons Co., New York.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.

Steam Shovels.
Bucyrus Co., So. Milwaukee.
C. W. Hunt Co., New York.
Marion Steam Shovel Co., Marion, O.
Mead-Morrison Mfg. Co., Boston.
Vulcan Iron Wks. Co., Toledo.

Steam Traps.
Albany Steam Trap Co., Albany.
American Blower Co., Detroit.
Geo. F. Blake Mfg. Co., New York.
Julian D'Este Company, Boston.
Golden-Anderson Valve Specialty Co., Pittsburg.
John Simmons Co., New York.
B. F. Sturtevant Co., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Wright Mfg. Co., Detroit.

Steel.
Wm. Jessop & Sons, New York.
B. M. Jones & Co., Boston.
Walworth Mfg. Co., Boston.

Steel Balls.
American Ball Co., Providence.
Hess-Bright Co., Phila.

Steel Concrete Construction.
Ambursen Hydraulic Cons. Co., Boston.
Frank B. Gilbreth, New York.
Tucker & Vinton Cor., New York.
Rogers-Shear Co., Warren, Pa.

Steel, High Speed.
Wm. Jessop & Sons, New York.
B. M. Jones & Co., Boston.

Steel Works Machinery.
Wellman-Seaver-Morgan Co., Cleveland.

Stencils.
Schwerdtle Stamp Co., Bridgeport.

Stokers—Mechanical.
Babcock & Wilcox Co., New York.
Model Stoker Co., Dayton, Ohio.
Westinghouse Mch. Co., Pittsburg.

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Structural Iron Work.
Chester B. Albree, Allegheny, Pa.
Frank B. Gilbreth, New York.
Berlin Const. Co., Berlin, Conn.
Broderick & Bascom Rope Co., St. Louis.
Browning Eng'g Co., Cleveland.
Interstate Eng'g Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Wm. B. Scaife & Sons Co., Pittsburg.

Sugar-House Machinery.
Am. Tool & Mch. Co., Boston.
Geo. F. Blake Mfg. Co., New York.
P. H. Morris, Philadelphia.

Superheaters.
Babcock & Wilcox Co., New York.
F. D. Potter, New York.
Power Specialty Co., New York.
Providence Eng'g Wks., Providence.

Surfacing Machines.
Thos. H. Dallett Co., Phila.

Switchboards.
C & C Electric Co., New York.

Tanks.
Allis-Chalmers Co., Chicago.
Atlantic Works, East Boston, Mass.
W. E. Caldwell Co., Louisville.
Flint & Walling Mfg. Co., Kendallville, Ind.
L. O. Koven & Bro., New York.
Mecklenburg Iron Wks., Charlotte, N. C.
Riter-Conley Mfg. Co., Pittsburg.
Wm. B. Scaife & Sons Co., Pittsburg.
Struthers-Wells Co., Warren, Pa.
Tippett & Wood, Phillipsburg, Pa.
Titusville Iron Co., New York.
Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.
Robt. Wetherill & Co., Chester, Pa.

Taps and Dies.
Crane Co., Chicago.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Standard Tool Co., Cleveland.

Tapes, Measuring.
Lufkin Rule Co., Saginaw, Mich.

Tenoning Machines.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.

Thermit Welding.
Goldschmidt Thermit Co., New York.

Thermometers.
Bristol Co., Waterbury.
Hohmann & Maurer Mfg. Co., Rochester.

Time Checks.
Am. Ry. Supply Co., New York.
Schwerdtle Stamp Co., Bridgeport.

Time Stamps, Automatic.
Calculagraph Co., New York.
Perry Time Stamp Co., Chicago.

Tin, Roofing.
American Sheet & Tin Plate Co., Pittsburg.

Tipples.
Mineral Ridge Mfg. Co., Mineral Ridge, O.

Tracing Cloth.
Kolesch & Co., New York.

Trade Marks.
Everett E. Kent, Boston.

Traveling Link Grates.
Green Engineering Co., Chicago.

Tumbling Mills.
S. Obermayer Co., Cincinnati.

Turnbuckles.
Broderick & Bascom Rope Co., St. Louis.
John Simmons Co., New York.

Turn Tables.
Arthur Koppel, New York.
Mead-Morrison Mfg. Co., Boston.
Tippet & Wood, Phillipsburg, Pa.

Turret Heads.
T. R. Almond Mfg. Co., Brooklyn.

Turret Lathes.
American Tool & Mch. Co., Boston.
American Tool Wks. Co., Cincinnati.
Bullard Mch. Tool Co., Bridgeport.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Twist Drills.
Standard Tool Co., Cleveland.

Underground Conduit Systems.
G. M. Gest, New York.

Upsetting Machinery.
Erie Foundry Co., Erie, Pa.

Vacuum and Draft Gauges.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester.

Vacuum Pumps.
Alberger Condenser Co., New York.
Am. Air Compressor Wks., N. Y.
Geo. F. Blake Mfg. Co., New York.
Clayton Air-Compress. Wks., N. Y.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
John H. McGowan Co., Cincinnati.
Platt Iron Works, Dayton, Ohio.
Snow Steam Pump Wks., New York.
Union Steam Pump Co., Battle Creek, Mich.
Henry R. Worthington, New York

Valves—Gas, Steam & Water.
Am. Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Wm. T. Bonner Co., Boston.
Boston Belting Co., Boston.
Wm. G. Coats, Newark, N. J.
Crane Co., Chicago.
Crosby Steam Gage & Valve Co., Boston.
John Davis Co., Chicago.
Julian D'Este Co., Boston.
Foster Eng'g Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburg.
Jenkins Bros., New York.
John H. McGowan Co., Cincinnati.
Manning, Maxwell & Moore, N. Y.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg.
Ross Valve Co., Troy.
John Simmons Co., New York.
Star Brass Mfg. Co., Boston.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.

Valves—Reducing.
Wm. G. Coats, Newark, N. J.
Golden-Anderson Valve Specialty Co., Pittsburg.

Ventilating Apparatus.
B. F. Sturtevant Co., Hyde Park, Mass.

Vertical Filing Systems.
Koller & Smith, New York.

Vises—Hand, Swivel and Stationary.
Erie Foundry Co., Erie, Pa.

Water-Closets.
John Simmons Co., New York.

Water Meters.
John Simmons Co., New York.
Henry R. Worthington, New York.

Waterproof Felt.
Hydrex Felt & Eng'g Co., New York.

Water Purifying Apparatus.
Harrison Safety Boiler Wks., Phila.
Wm. B. Scaife & Sons Co., Pittsburg.
Warren Webster & Co., Camden, N.J.

Water Softening Apparatus.
Harrison Safety Boiler Wks., Phila.
N. Y. Continental Jewell Filt. Co., New York.
Wm. B. Scaife & Sons Co., Pittsburg.
Warren Webster & Co., Camden, N.J.

Water-Wheels.
Abner Doble Co., San Francisco.
Mecklenburg Iron Wks., Charlotte, N. C.
Pelton Water Wheel Co., San Francisco.
Platt Iron Works, Dayton, Ohio.
Poole Eng'g & Mch. Co., Baltimore.
Power Specialty Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.
R. D. Wood & Co., Phila.

Water-Wheel Governors.
Lombard Governor Co., Ashland, Mass.
Woodward Governor Co., Rockford, Ill.

Water-Works Pumping Mchy.
Allis-Chalmers Co., Chicago.
Geo. F. Blake Mfg. Co., New York.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Holly Mfg. Co., New York.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Platt Iron Works, Dayton, Ohio.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
Robt. Wetherill & Co., Chester, Pa.
R. D. Wood & Co., Phila.
Henry R. Worthington, New York.

Water-Works Supplies.
American Well Wks., Aurora, Ill.
W. E. Caldwell Co., Louisville.
Power Specialty Co., New York.
John Simmons Co., New York.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
R. D. Wood & Co., Phila.

Wells—Artesian.
Clayton Air Compress. Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Platt Iron Works, Dayton, Ohio.

Well Drilling Machines.
Star Drilling Machine Co., Akron, O.

Well Supplies.
American Diamond Rock Drill Co., New York.
American Well Wks., Aurora, Ill.
Broderick & Bascom Rope Co., St. Louis.
Laidlaw-Dunn-Gordon Co., New York.
John Simmons Co., New York.
Star Drilling Machine Co., Akron, O.
Williams Bros., Ithaca, N. Y.

Wheelbarrows.
Stuebner Iron Wks., Lond Isld. City.

Wind Mills.
W. E. Caldwell Co., Louisville.
Flint & Walling Mfg. Co., Kendallville, Ind.

Wire-Drawing Machinery.
Morgan Construction Co., Worcester.
National Machinery Co., Tiffin, O.
Waterbury Farrel Fdy. & Mch. Co., Waterbury.

Wire Cloth and Screen.
W. S. Tyler Co., Cleveland.

Wire Lath.
Clinton Wire Cloth Co., N. Y.
Roebling Construction Co., N. Y.

Wire Nail Machinery.
National Machinery Co., Tiffin, Ohio.

Wire Rope.
Am. Hoist & Derrick Co., St. Paul.
Broderick & Bascom Rope Co., St. Louis.
Jeffrey Mfg. Co., Columbus.

Wood Blocks.
U. S. Wood Preserving Co., New York.

Wood-Working Machinery.
Chicago Pneumatic Tool Co., Chicago.
Fay & Egan Co., Cincinnati.
Frank Machinery Co., Buffalo.

Worm Gearing.
Morse, Williams & Co. Phila.
R. D. Nuttall Co., Pittsburg.

For Alphabetical Index to Advertisers see page 11.

General Electric Company

Electric Hoists

Modern construction of modern buildings includes the use of our electric hoists

General view of New York Public Library building during erection, showing tower and boom derricks operated by our electric hoists.

A clean cut, systematic and business-like building operation with no obstruction to traffic and no objectionable features.

Principal Offices: Schenectady, N. Y.

New York Office
44 BROAD ST.

SALES OFFICES IN ALL LARGE CITIES

648

Please mention The Engineering Magazine when you write.

STANDARDS AND GAUGES

Pratt & Whitney Plug and Ring Gauges. Accuracy: within $\frac{1}{50,000}$ inches.

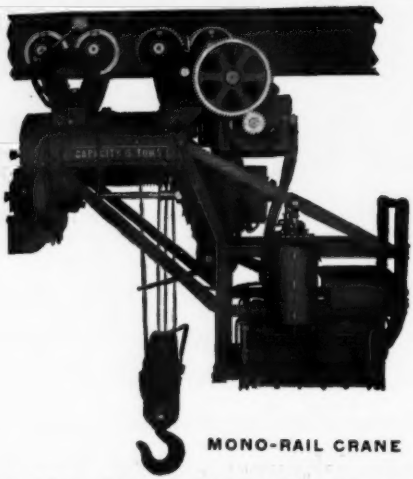
Regularly Made in Both English and Metric Standards

THREAD GAUGES
PIPE THREAD GAUGES
DOUBLE END LIMIT GAUGES
MASTER CAR BUILDERS' GAUGES
CALIPER GAUGES
STANDARD MEASURING MACHINES

PRATT & WHITNEY CO., 111 Broadway, - NEW YORK
Works: HARTFORD, CONN.

OFFICES.—BOSTON: 144 Pearl Street. PHILADELPHIA: 21st & Callowhill Streets. PITTSBURG, PA.: Frick Building. CHICAGO: 46 South Canal Street. ST. LOUIS, MO.: 516 North Third Street.

SPRAGUE ELECTRIC HOISTS



MONO-RAIL CRANE

SPRAGUE ELECTRIC COMPANY

GENERAL OFFICES: - - - - 527 West Thirty-fourth Street, NEW YORK

NILES BORING MILLS

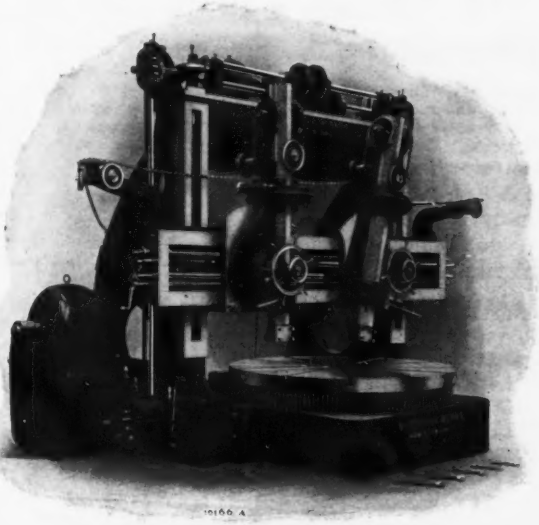
Twenty-five sizes from 30-in. to 30 feet swing.

For use with modern high-power tool steels. . . . .

Niles-Bement-Pond Co.

111 Broadway,
NEW YORK.

Offices:
Boston, 144 Pearl St.
Chicago, Western Union Building.
Pittsburgh, Frick Bldg.
St. Louis, 516 North Third St.
Philadelphia, 21st & Callowhill Sts.
London, 23-25 Victoria St., S. W.



New Niles 10 Foot Extra Heavy Boring and Turning Mill.

30 & 40-ton Niles Cranes, with 5-ton Auxiliary Hoists, 62-ft. Span. National Steel Foundry Co., New Haven, Conn.

NILES CRANES

NILES-BEMENT-POND CO., 111 Broadway, NEW YORK, U. S. A.

Please mention The Engineering Magazine when you write.

THE WM. T. BONNER CO.

Merchant Engineers and Manufacturers

"WILTBONCO" ENGINEERING SPECIALTIES

Reflex Water Gages
Wiltbonco Gage Mountings
Wiltbonco-Orange Glass Tubes
Cooperite Sheet Packing
Safety Plastic Metallic Packing
Cushion Pressure Seated Control Cocks
Freeport Blow Off Valves
Freeport Valves for Steam and Water
Wiltbonco-Hogan Waste Oil Filters
Wiltbonco-Fraser Feed Water Regulators
Wiltbonco-Monarch Gage Glass Protectors

HEAD OFFICE AND FACTORY: 246 Summer Street, BOSTON | N. Y. SALES OFFICE: 141 Broadway, NEW YORK

TAYLOR BEST YORKSHIRE IRON
For STAYBOLTS, AXLES, PISTON RODS CRANK PINS, and OTHER USES where an iron of the highest quality is required.

MUSHET STEELS
HIGH-SPEED, SPECIAL and TITANIC
MUSHET HIGH-SPEED STEEL TWIST DRILLS

B. M. JONES & CO.
141 MILK ST., BOSTON — 143 LIBERTY ST., NEW YORK

KINNEAR STEEL ROLLING DOORS AND SHUTTERS

SEND FOR CATALOGUE "L"

THE KINNEAR MFG. CO., Columbus, Ohio, U. S. A.

BOSTON 85 WATER ST. | CHICAGO 112 CLARK ST. | PHILADELPHIA 1011 CHESTNUT ST.

FUEL GAS PLANTS FOR FACTORIES.

COMPLETE INSTALLATION, INCLUDING **Gas Blast Furnaces** FOR ANY KIND OF WORK

THOROUGH EFFICIENCY, ECONOMY AND SAFETY WARRANTED

Descriptive Pamphlets on Application to

AMERICAN GAS FURNACE CO., - 23 JOHN STREET, NEW YORK.

AMERICAN

COMBINED PRESSURE AND RECORDING GAUGES.
POP SAFETY, CYLINDER AND UNDERWRITER RELIEF VALVES.
Unexcelled. Guaranteed to give satisfaction. Send for Catalog.

MANUFACTURED BY
AMERICAN STEAM GAUGE AND VALVE MANUF'G COMPANY,
BOSTON. NEW YORK. CHICAGO. PHILADELPHIA.

HENRY MAURER & SON,

.....MANUFACTURERS OF.....

High Grade Fire Brick.

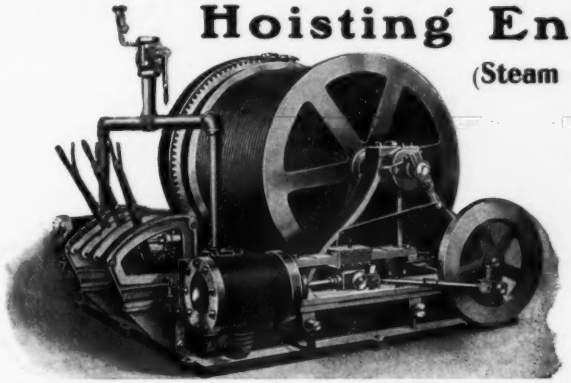
420 EAST 23d STREET, - - - NEW YORK CITY.

Fire Brick stamped Henry Maurer, No. 1, are Standard; with such, and good quality Fireclay, satisfactory results follow.

LIDGERWOOD

Hoisting Engines

(Steam and Electric)



Are built in all sizes for any power or service.

More than 24,000 In Use.

Combined Friction Drum and Brake and Reversible Link Motion Hoisting Engine

This engine is unquestionably the most economical engine yet made for mine hoisting, as after starting the links may be hooked up, cutting off the steam at any point of stroke desired, thus doing most of the work by the expansion in the cylinder. If desirable, the engine can be used for double shaft work by throwing the friction into gear permanently and using it as a regular link motion engine, hoisting the cage in one shaft while it lowers it in the other.

LIDGERWOOD MFG. CO., 96 Liberty St., New York

Philadelphia, Chicago, Boston, Pittsburg, Atlanta, New Orleans, Portland, Ore., Cleveland, Seattle.

WESTON

Standard Portable

Voltmeters, Ammeters, Wattmeters

Strictly High Grade Recognized as Standards

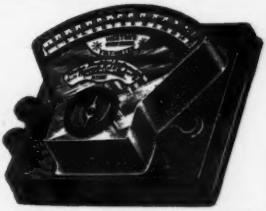
Weston Electrical Instrument Co.

Main Office and Works

Waverly Park, **NEWARK, N. J.**

BERLIN: European Weston Electrical Instrument Co., Ritterstrasse 88
LONDON: Elliott Bros., Century Works, Lewisham
PARIS, FRANCE: E. Cadiot, 12 Rue St. Georges

New York Office: 74 Cortlandt Street.



WESTON STANDARD VOLTMETER

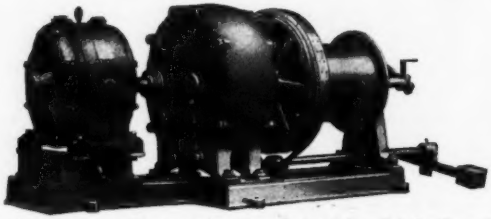
GUILD & GARRISON

Kent Ave., cor. South 10th Street **BROOKLYN, N. Y.**

Take Roosevelt, Grand, or E. 23d Street Ferry from New York.

STEAM PUMPS
VACUUM PUMPS
FILTER-PRESS PUMPS
DRY AIR COMPRESSORS
VACUUM APPARATUS
CONDENSERS
AMMONIA PUMPS
ACID BLOWERS

Westinghouse Motors



Westinghouse Induction Motor driving Hunt Enclosed Gear Friction Drum Hoist.

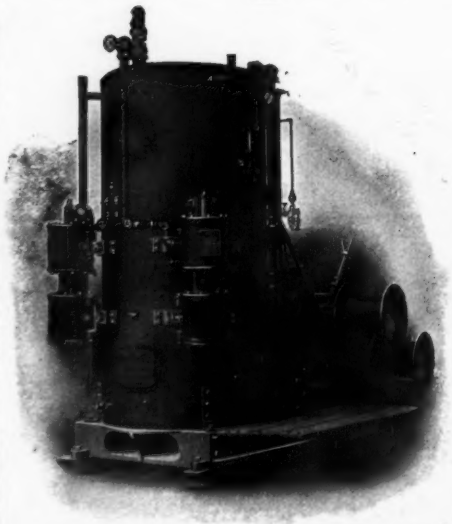
Westinghouse Motors are adaptable to every class of machine and meet every condition of service, whether constant or variable speed, alternating or direct current.

Westinghouse Electric & Mfg. Co.

Sales Offices in all large cities. Pittsburg, Pa.

For Canada: Canadian Westinghouse Co., Limited, Hamilton, Ontario.

Westinghouse Steam Driven Air Compressors



The illustration shows manner of attaching compressors to boiler of a hoisting engine. A convenient and space-saving arrangement for supplying air for pneumatic tools, sand blast, paint spraying, etc., in the erection of steel structures; also for railway contractors in tunnel and other work requiring compressed air.

The Westinghouse Air Brake Company

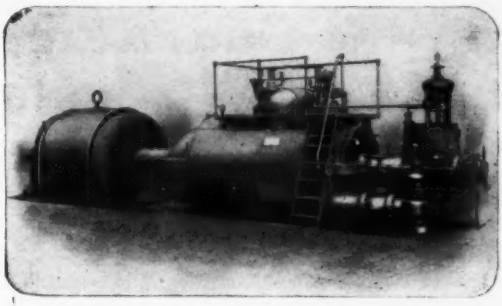
The Air Brake Builders

Eastern Office
111 Broadway, New York

Western Office
1515 Railway Exchange Bldg., Chicago

South Western Office
2932 North Broadway, St. Louis

For Canada
Canadian Westinghouse Co., Ltd.
Hamilton, Ontario



The Westinghouse Machine Co.

Recently contracted with three of the largest power companies in Greater New York for over 50,000 H. P. of

Westinghouse-Parsons Steam Turbine Generating Units

Two Units for the New York Edison Co.
One Unit for the Brooklyn Edison Co.
Two Units for the Brooklyn Heights Ry. Co.

Each Unit of 7,500 K. W. Normal, or 15,000 H. P. Ultimate Capacity

This class of service may be considered of the most exacting character, demanding the maximum degree of reliability and economy.

Address nearest sales office for particulars

New York, 10 Bridge St. | Chicago, La Salle St. | Pittsburg, Westinghouse Bldg.
Boston, 131 State St. | Cincinnati, 1111 Traction Bldg. | Philadelphia, Stephen Girard Bldg.
Charlotte, N. C., So. Tyron St. | Atlanta, Equitable Bldg. | Denver, 512 McPhee Bldg.
San Francisco, Hunt, Mirk & Co., 614 Mission St.

AN *unconditional* guarantee.

Many roofs, especially Tin Roofs, are guaranteed—"on condition of frequent painting with three coats of our X Y Z extra heavy paint" or something like that. The owner is usually found doing the repairing at his own expense. If he *does* fulfil the conditions he is constantly painting his roof. On large buildings this expense is enormous. Yet, if the painting is neglected the roof quickly rusts out and leaks.

Thousands of dollars worth of goods are annually destroyed by leaky Tin Roofs.

It is the result of having the kind of roof that *can't* really be guaranteed.

On the other hand, every Barrett Specification Roof (of Coal Tar Pitch, Felt and Slag or Gravel) carries with it an unconditional guarantee *for ten years.* No "ifs," no "buts," no "provided."

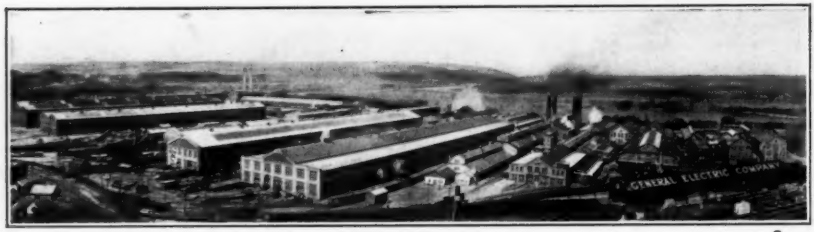
In point of fact, a Barrett Specification Roof probably won't leak for *twenty* years.

We know of some that are *thirty* years old and *haven't leaked yet.*

It's the result of having a roof that *can* really be guaranteed.

Observe that there is no "X Y Z Paint" clause in *this* guarantee. Maintenance costs nothing. The Barrett Specification Roof is absolutely water-tight, *without* coating, painting or repairs.

The enormous plant of the General Electric Company (illustrated herewith) is now



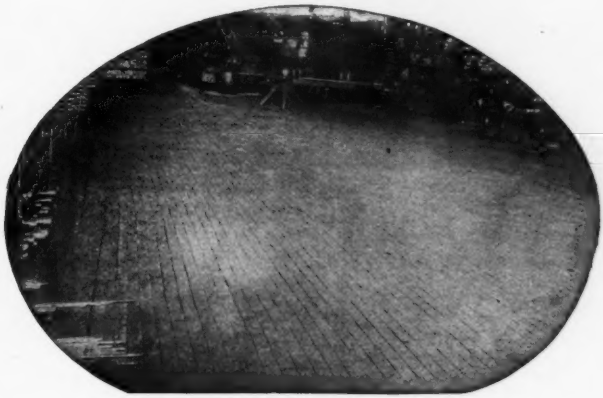
covered with *one million square feet* of Slag or Gravel Roofs. Imagine the outlay that would be required for the periodical repainting of such an area of tin!

And the first cost of a Barrett Specification Roof is less than one of tin.

Barrett's Hand Book, just issued, is an important little treatise on the Roofing and Waterproofing subjects. It will be mailed free to anyone interested, on application. BARRETT MANUFACTURING CO., New York, Chicago, Philadelphia, St. Louis, Cincinnati, Cleveland, Kansas City, New Orleans, Allegheny, Minneapolis.

U. S. WOOD BLOCK PAVEMENT

CREO-RESINATE PROCESS



SHAFTING STORAGE ROOM PARDEE STEEL CO.

THIS pavement, which on heavily traveled streets outwears granite, is of special value for **Shop Floors** where, on account of the elasticity of the wood it is proof against injury from heavy castings, etc., which soon destroy asphalt or stone.

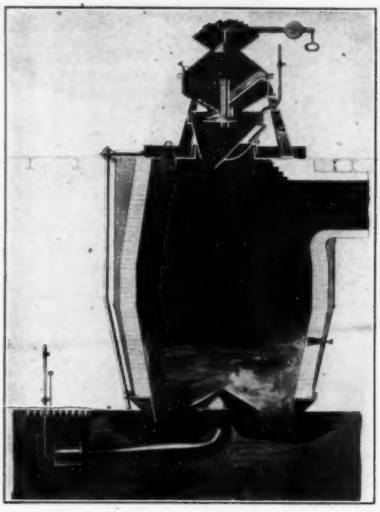
It has now been successfully used in many of the greatest iron-working establishments in the country.

CLEANLY, NOISELESS, NON-INFLAMMABLE

Booklet on the subject free of charge

UNITED STATES WOOD PRESERVING CO.

29 BROADWAY, NEW YORK CITY



Morgan Continuous Gas Producer with Automatic Feed.

PRODUCER GAS

Engineers Agree

that the cheapest and best way of

PRODUCING HEAT

is by the use of a modern Producer-Gas Generator with Automatic Feed.

A saving of 50% in the fuel bill is often obtained.

More heat is wasted in this world than is usefully employed. This problem of lost energy is now being solved by the modern Gas Producer, which commands the careful consideration of every manager and engineer interested in heating operations consuming more than three tons of coal per day.

Producer Gas is usually as cheap as Natural Gas and often cheaper, even in the Natural Gas regions.

The advantages of using Producer Gas are:

1. Its great ECONOMY—often over 50 per cent., seldom under 25 per cent.
2. The OUTPUT of a plant is almost always increased—40 per cent. not being uncommon.
3. The fire is EASILY CONTROLLED; hence the material is neither over nor under heated.
4. PERFECT COMBUSTION is attained resulting in an absence of smoke.
5. In metal heating the loss of OXIDATION is reduced to about one-third of the usual loss by direct firing.
6. A UNIFORM HEAT can be maintained. This is made possible by automatically feeding and spreading the coal in the Producer.
7. NO DELAYS for cleaning or starting fires are necessary. The Producer is continuous in its operation.
8. There is a considerable SAVING OF LABOR due to handling all the fuel mechanically at one point.

USES OF PRODUCER GAS.

Among the many industries to which Producer Gas can be advantageously applied are the following: Heating and melting of Iron and Steel; Burning of Cement, Lime, Fire Brick, Terra Cotta, Pottery, Sewer Pipe, Brick, etc.; Roasting, Smelting and Refining of all metallic ores. Heating the retorts, stills, kettles, vaporating pans and roasting floors in Chemical Works.

Firing of all forms for Enamel Ware, etc. Heating of Iron for Welding and Large Forgings. Manufacture of Glass, Carbons, Malleable Iron, Steel Castings, Soda Ash, Phosphates, Paints, etc.

Heating of all forms of large Furnaces, Dry Kilns and Ovens.

Most of the leading makes of Gas Producers are in operation at the plant of the Lackawanna Steel Co., Buffalo, N. Y. Of all these the only make whose merits have resulted in a second order is that of the Morgan Construction Co. We have received four successive orders aggregating 52 Producers for this plant. o four successive orders aggregating 74 Producers for the Illinois Steel Co.

On tests continued over two weeks at the plant of the Grand Crossing Tack Co., So. Chicago, Robt. W. Hunt & Co. found that our Producers were maintaining an average efficiency of 92 per cent. This we believe to be fully 10 per cent. higher than the average results obtained by any other Gas Producer.

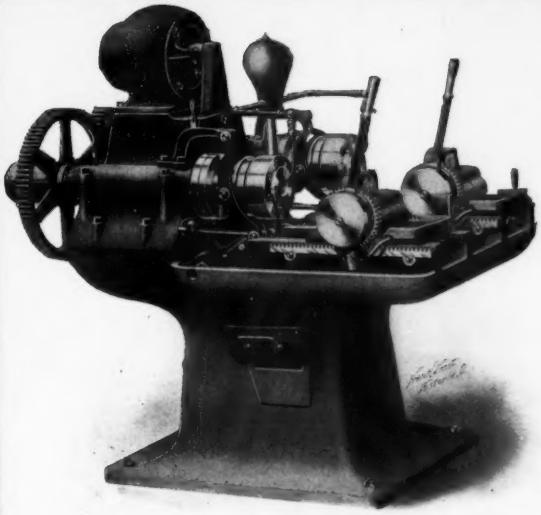
Write for our new 52 pp. illustrated catalogue. It contains much instructive information regarding Producer Gas.

MORGAN CONSTRUCTION COMPANY

40 Exchange Place, ... NEW YORK

WORKS: WORCESTER, MASS.

BOLT & NUT MACHINERY



Heading Machines
Nut Machines
Bolt Threading Machines
Bolt Pointers
Washer Machines
Forming and Bending Machines
Shears
Spike Machines
Automatic Cold Rivet and Bolt Headers

THIS cut shows the National Bolt Cutter with Motor Drive. An excellent combination which insures the utmost efficiency of operation. .. ..

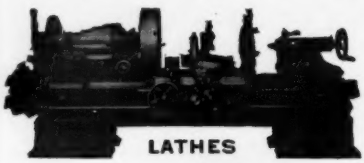
It would be a good plan to have Catalogue "C" on file

NATIONAL MACHINERY CO.
TIFFIN, OHIO, U.S.A.

ENG. MAG. CURLEY

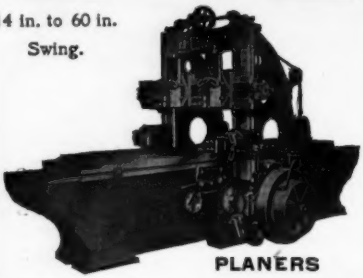
THE AMERICAN TOOL WORKS CO.

CINCINNATI, U. S. A.



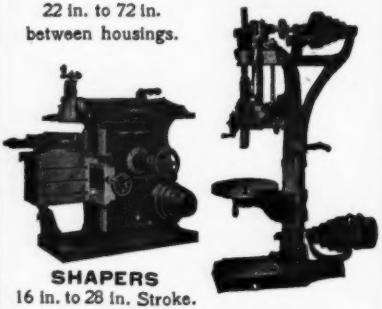
LATHES

14 in. to 60 in. Swing.



PLANERS

22 in. to 72 in. between housings.



SHAPERS

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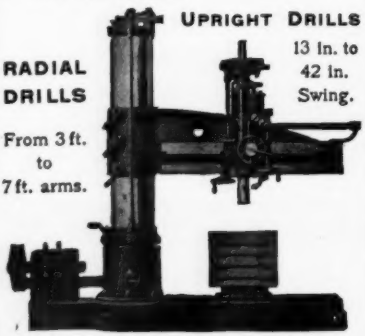
UPRIGHT DRILLS

13 in. to 42 in. Swing.

RADIAL DRILLS

From 3 ft. to 7 ft. arms.

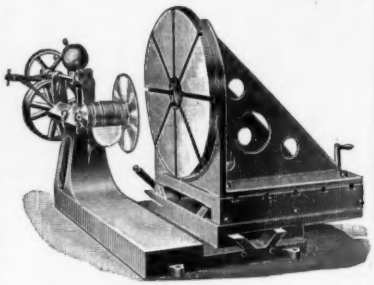


Belt, or Electric Motor Drive

THE MOST MODERN LINE IN THE WORLD.

WAGNER

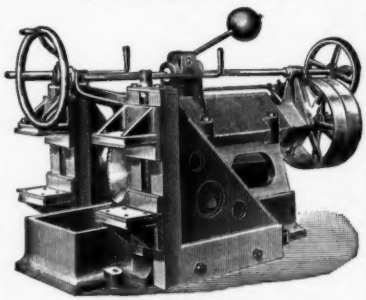
Cold Saws



ADVANTAGES:

Head swivels--- cuts any angle.	Have automatic feed according to shape or hardness of material to be cut.	Automatic indication of dull saws.
Built in seven sizes, beds to suit require-ments.	Rigid and simple construc-tion.	Automatic throwing out of feed when cut is completed

Many other special features.



BIRDSBORO

Steel Foundry & Machine Co.

FORMERLY CALLED DIAMOND DRILL & MACHINE CO.

BIRDSBORO.

718 Real Estate Bldg., PHILADELPHIA, PA.

52 Broadway, N. Y CITY.

The Morse Twist Drill and Machine Co.

NEW BEDFORD, MASS., U. S. A.

ESTABLISHED IN 1864.

OUR TWENTIETH CENTURY DRILL.

with its bright finished shank and ground relief, dull gray grooves and black tang makes a most artistic tool in appearance and its beauty will certainly appeal to you.

However, its beauty does not lie entirely on the surface—it is something more than "skin" deep, for it will do the work required of it in a manner that cannot help but bring favorable comments.

Both body and shank are ground on centers after hardening which insures its running true and accurate to size. The large amount of radical clearance lessens to a great degree the friction of the drill in the hole.

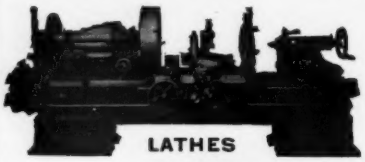
This drill, as well as other tools of our manufacture, is very necessary in the building of railroads and bridges, in the machine and repair shop, in fact, every place where tools are used.

MORSE

tools are kept to the standard by careful inspection as to quality and accurateness.

In addition to drills we make Reamers, Cutters, Chucks, Taps, Dies, Machines and Machinists' Tools and several other lines fully illustrated and described in our last catalogue, a copy of which may be had on a request for same.

THE AMERICAN TOOL WORKS CO.
CINCINNATI, U. S. A.



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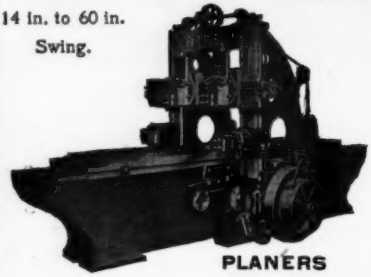

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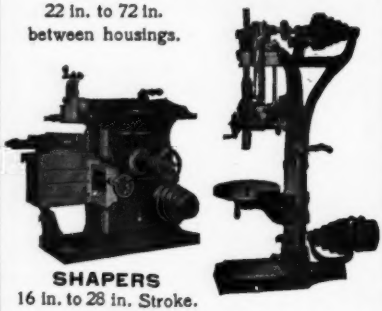

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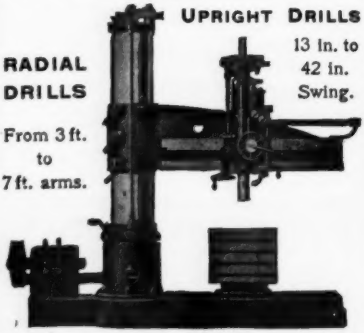
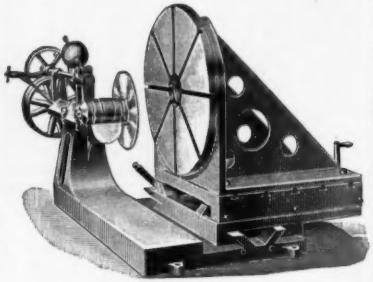


Belt, or Electric Motor Drive
THE MOST MODERN LINE IN THE WORLD.

WAGNER
Cold Saws



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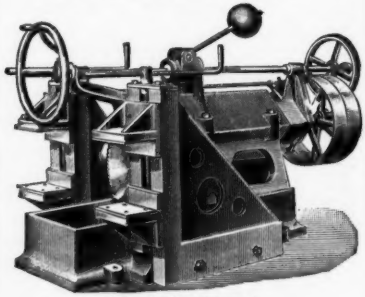
Automatic throwing out of feed when cut is completed

Many other special features.



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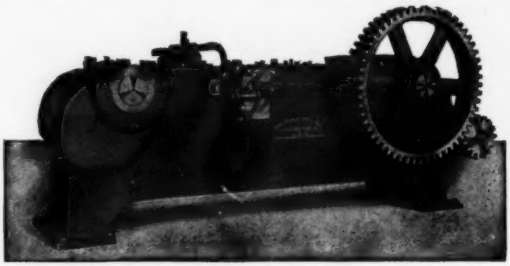

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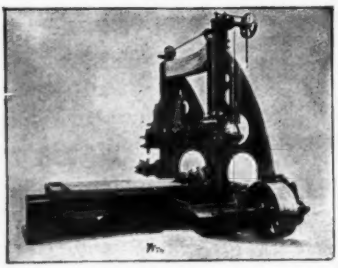

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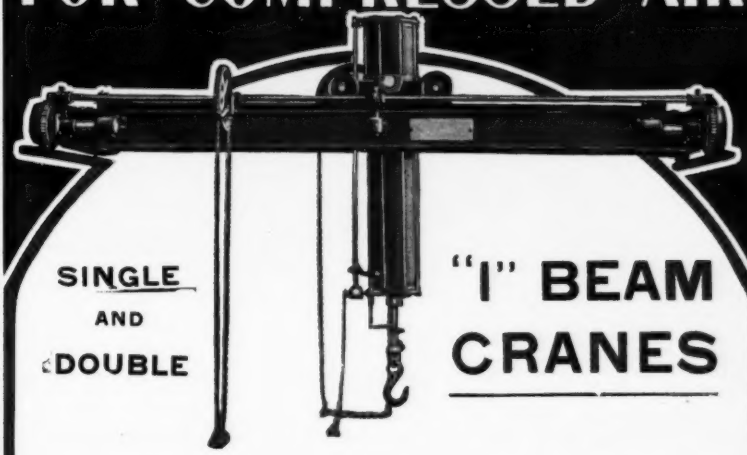

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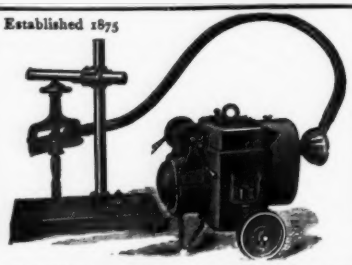

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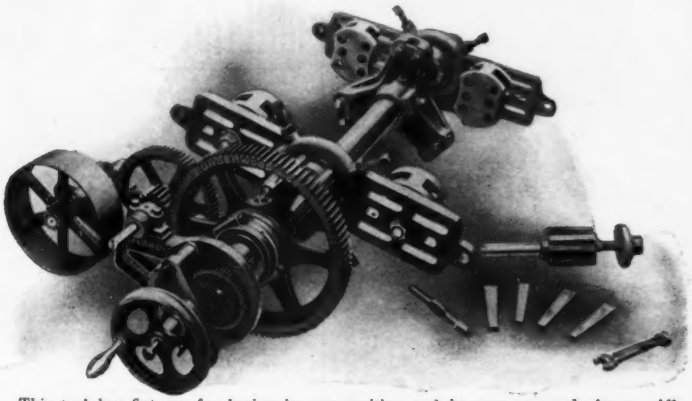

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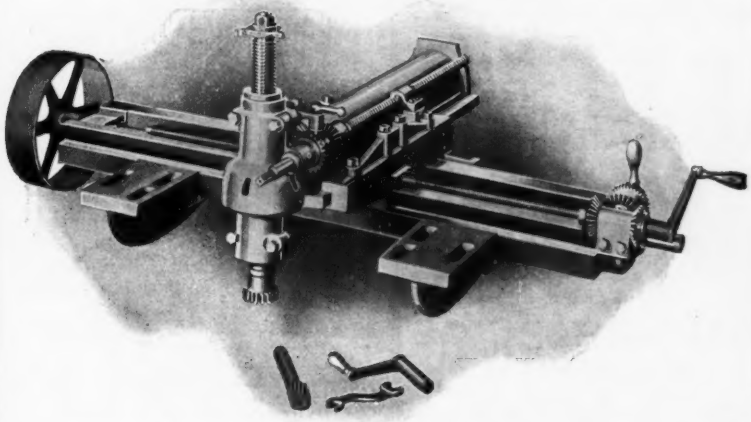

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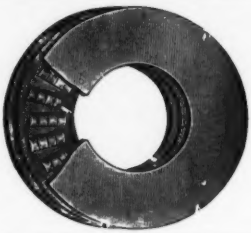

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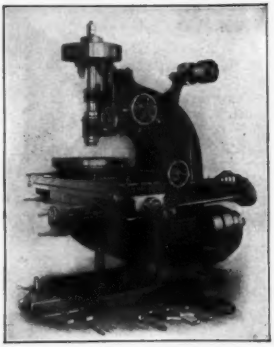

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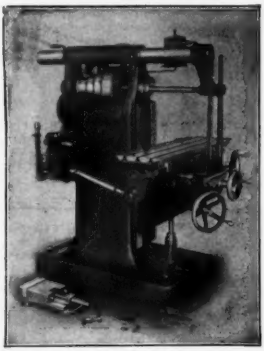

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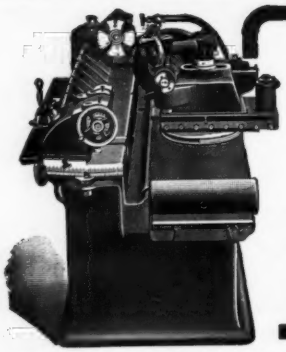

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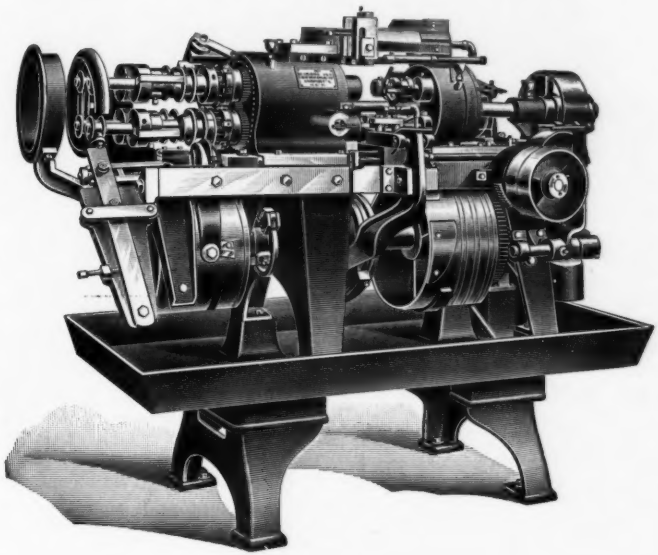

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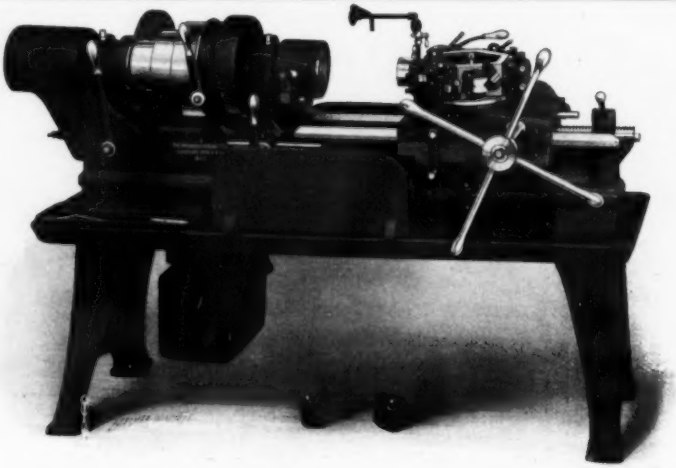

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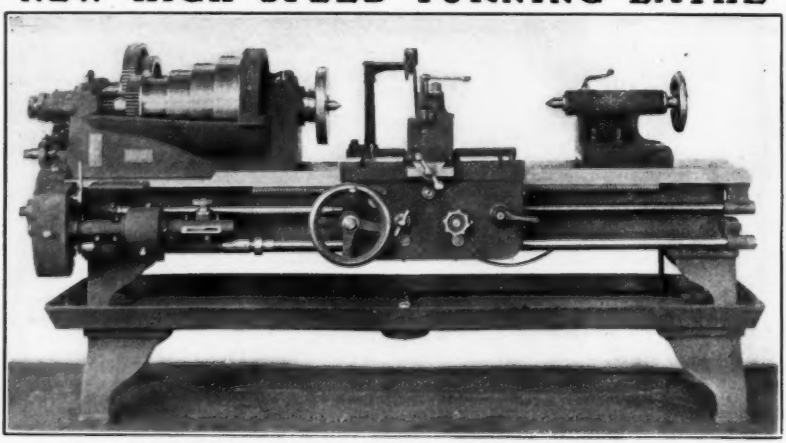

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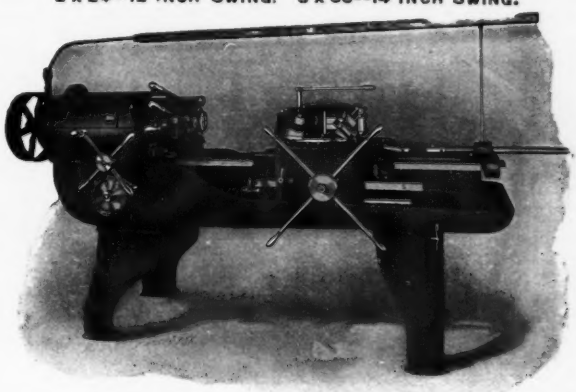

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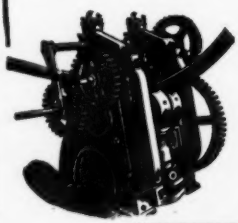

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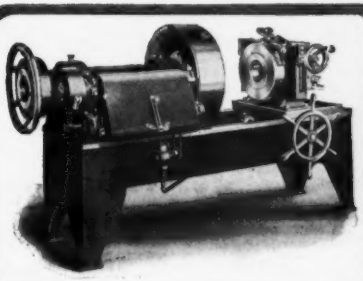

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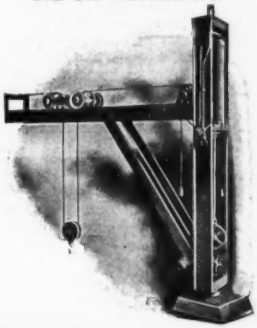

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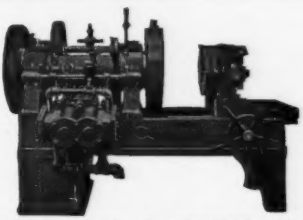

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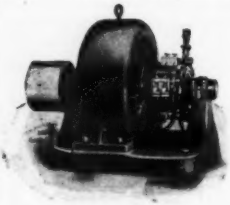

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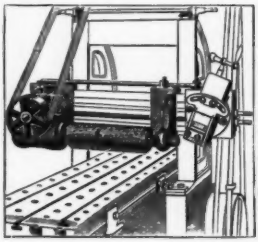

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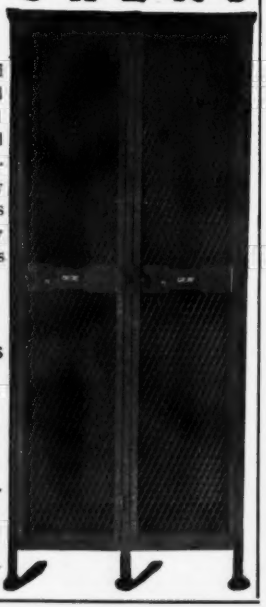

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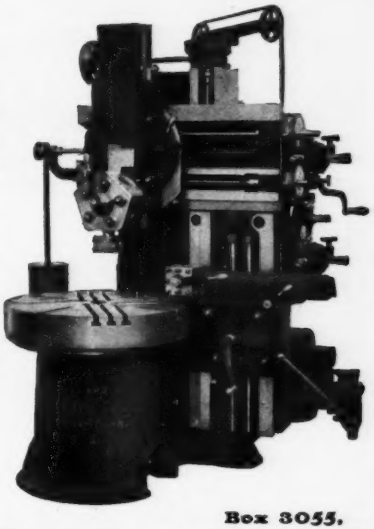

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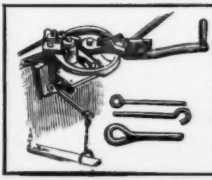

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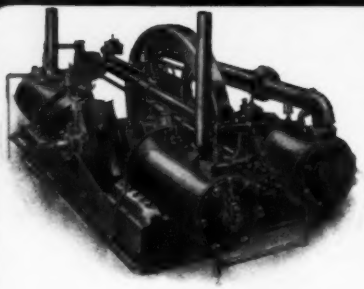

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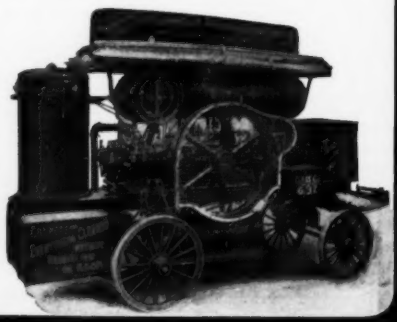

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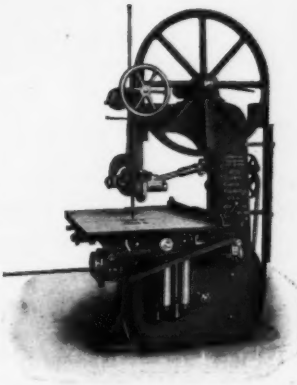

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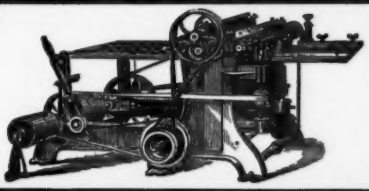

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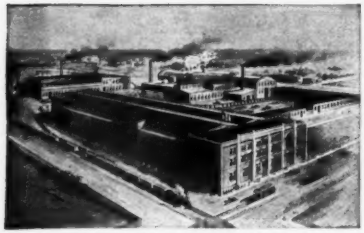

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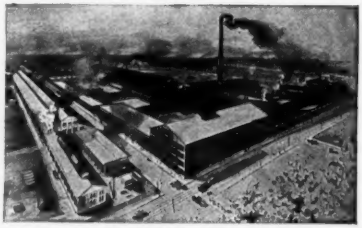

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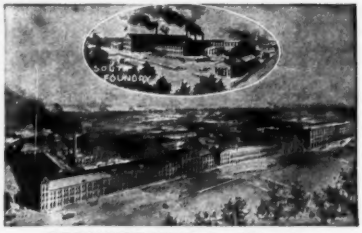

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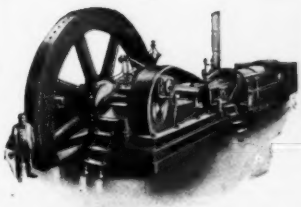

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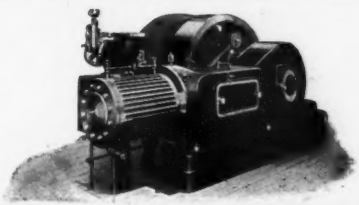

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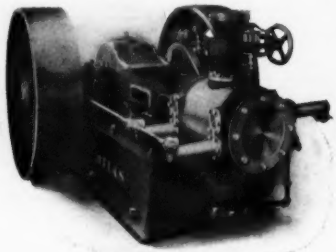

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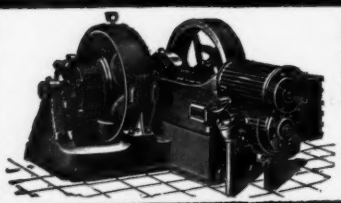

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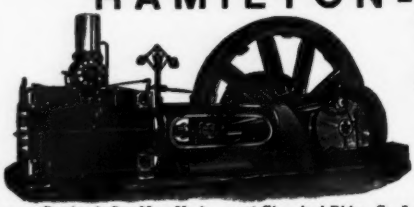

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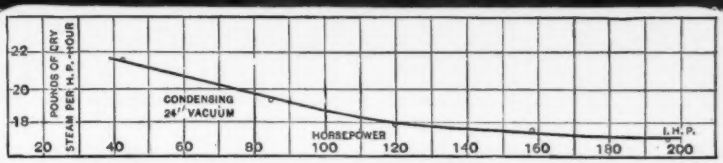

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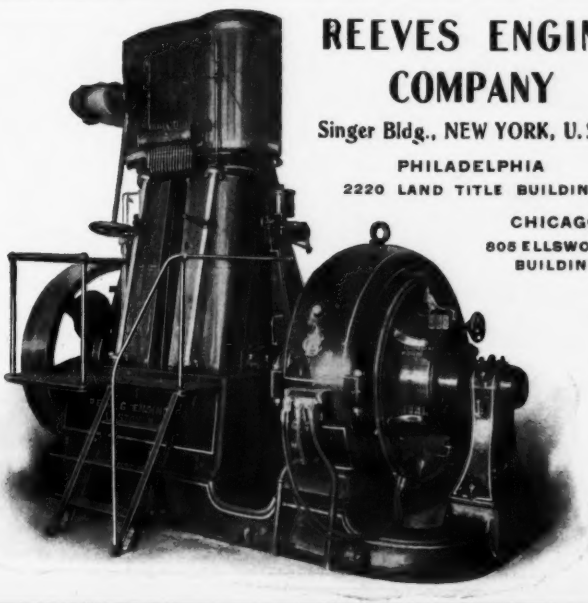

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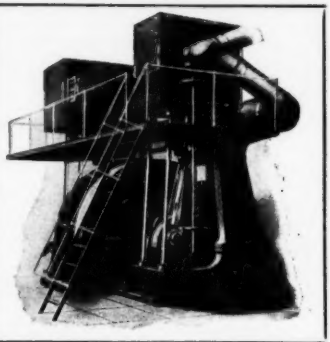

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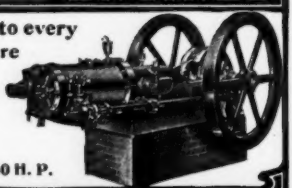

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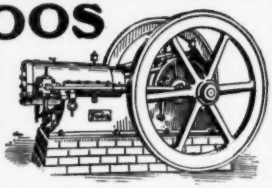

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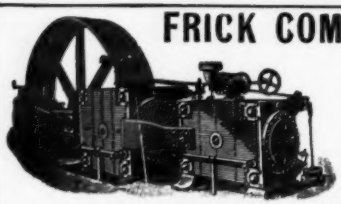

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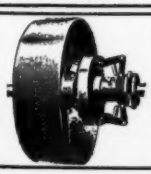

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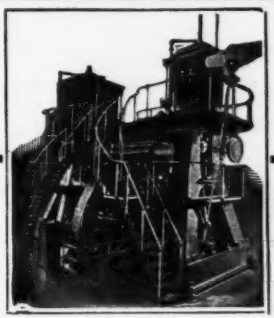

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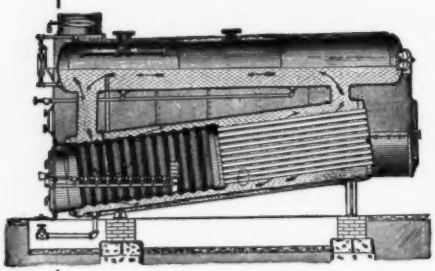

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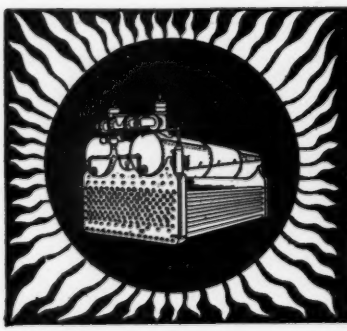

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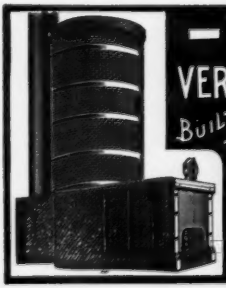

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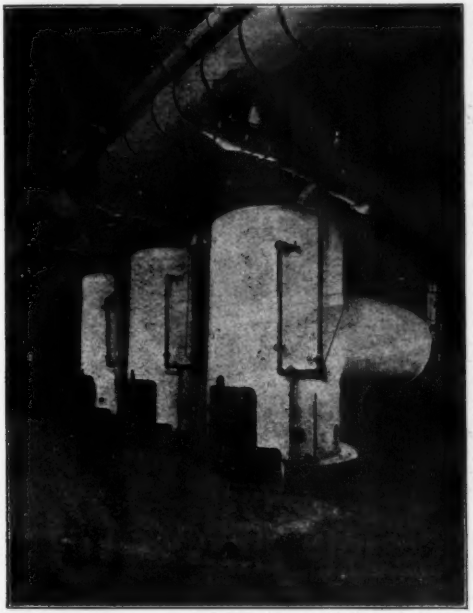

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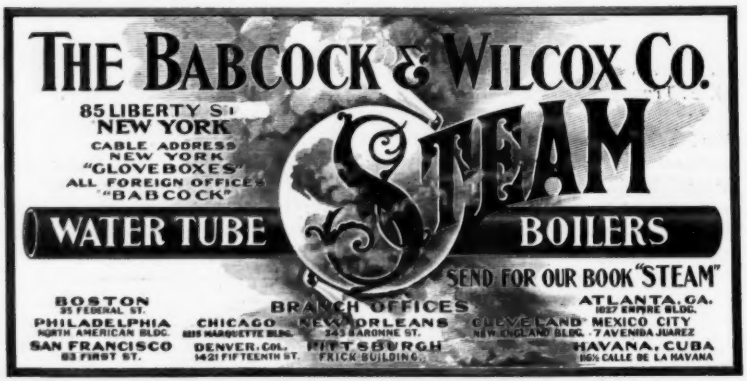

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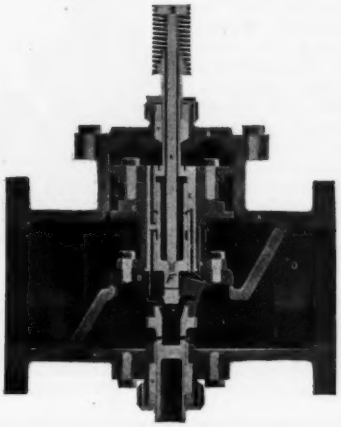

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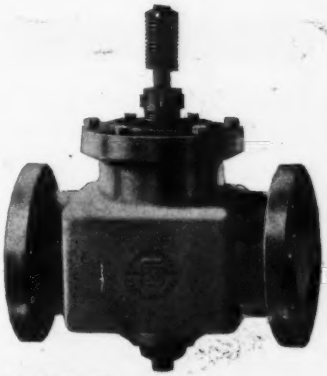

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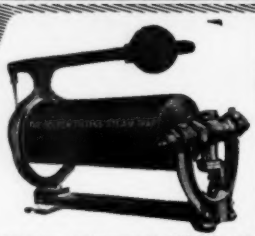

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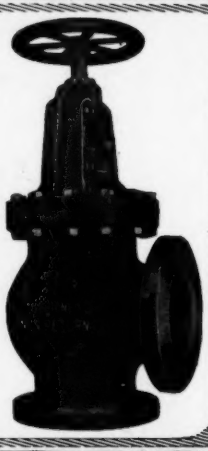

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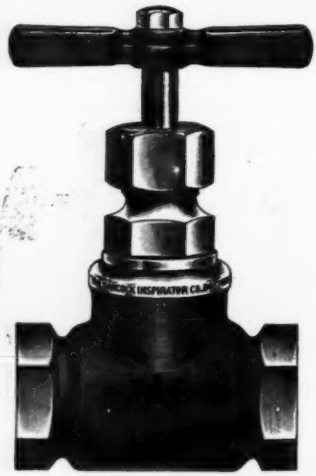

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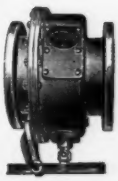

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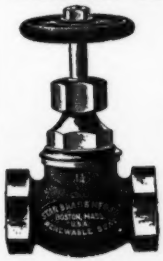

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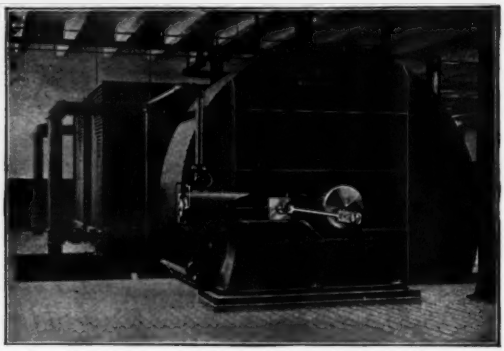

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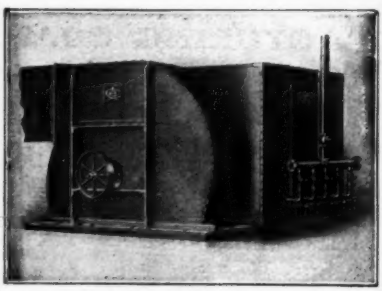

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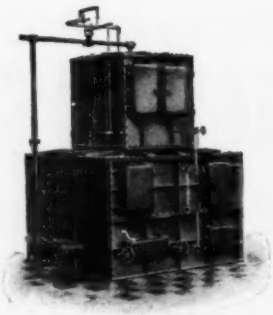

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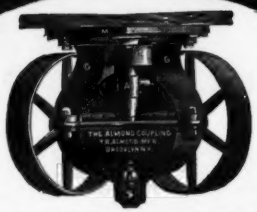

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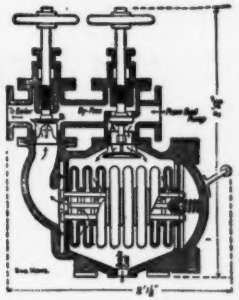

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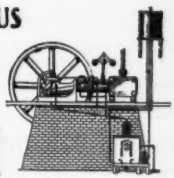

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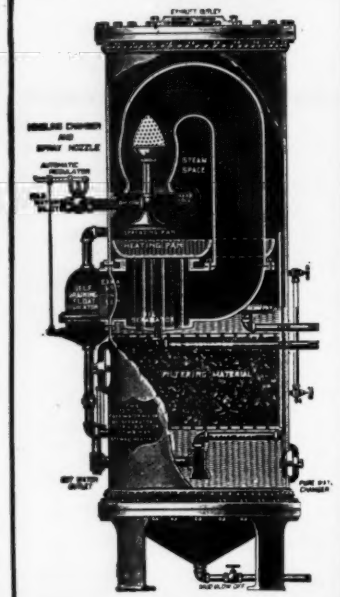

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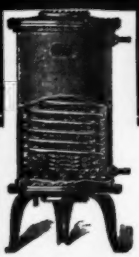

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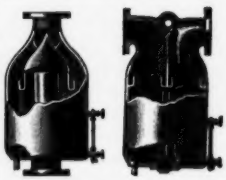

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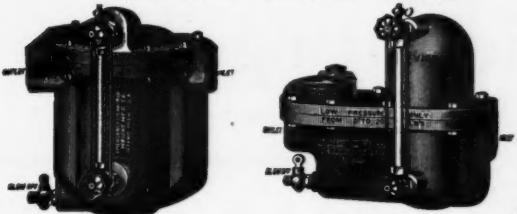

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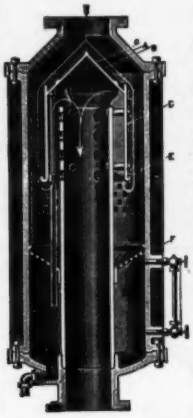

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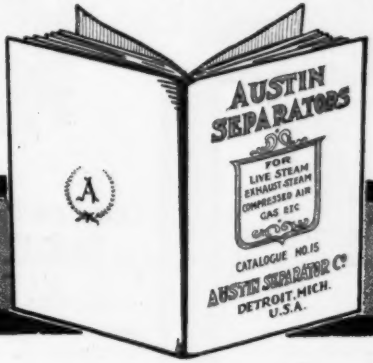

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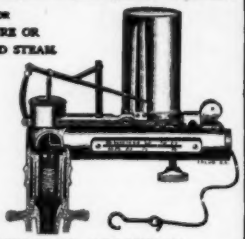

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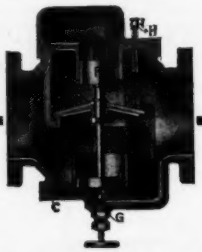

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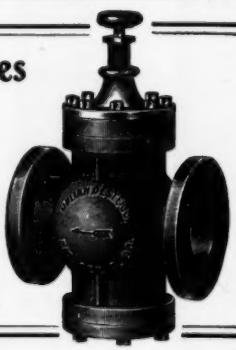

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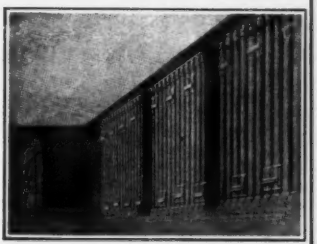

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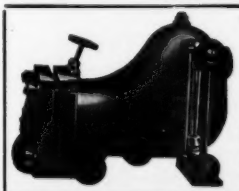

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PARTIAL LIST OF THE FORMS DESCRIBED

ORGANIZATION
- Chart of authority
- General office staff
- Location of officials
- Department of Product
- Department of Plant
- Sales department
- Purchasing department
- System charts

OFFICE
- Wages cost and distribution sheets
- Cost statement
- Itemized cost summary
- Sales sheet
- Cash received statement
- Daily balance sheet
- Shipping directions
- Correspondence receipts
- Order record
- Acknowledgment of orders
- Pay receipts
- Credit memorandum
- Advertising department records
- Inventory sheet
- Voucher registers
- Purchase voucher
- Purchase voucher remittance slip
- Check register
- Correspondence
- Indexing
- Credit form
- Traveler's expense weekly statement
- Traveler's expense yearly summary
- Claim slip for errors
- Employment record
- Pay rolls and pay envelopes
- Pay roll bill and specie specification
- Accounting forms
- General expense statement

PURCHASING DEPARTMENT
- Order tracing form
- Requisitions and orders
- Original and duplicate purchase orders
- Quotation record card
- Departmental purchase requisitions
- Purchase order
- Purchase vouchers
- Supplies urgently required

DRAWING OFFICE
- Requisition for blue prints
- Special requisition form
- Drawing room time card
- Drawings record
- Indexing
- Drawings issued
- Drawings out of place
- Blue prints issued

PRODUCTION DEPARTMENT
- Requisitions on foundry, storeroom, pattern shop, drafting office, etc.
- Work in progress record
- Rush order
- Inventory card
- Regular factory production orders
- Color schemes of production orders
- Erection tools lists
- Bills of material
- Typewritten production order
- Stockroom production order
- Repair orders
- Tracers
- Spoiled and defective material report
- Small orders

STORE ROOM AND TOOL ROOM
- Stores index cards
- Stores replenishment orders
- Material returned card
- Material received records
- Material rejected
- Stores ledger or inventory
- Requisition on storeroom
- Stores received
- Stores rejected
- Tool room charge sheet
- Tool room reports
- Workmen's tool record

TIME RECORDS
- Daily time card
- Outside work card
- Time cards for short operations
- Time card sorting boxes
- Outside foreman's report
- Outside erecting instructions
- Weekly time card—outside workmen
- Piece-rate card
- Piece-rate revision card
- Piece-work report
- Erector's expense account
- Miscellaneous time cards
- Gang time card
- Forms for outside use
- Piece-rate contracts and records
- Piece-rate notification
- Regular and special time charge sheet

RECEIVING AND SHIPPING DEPARTMENTS
- Shipping report
- Notification of shipment—to Cost Department, to customer, to Financial Department
- Shipping tickets
- "Ready for Shipment" memorandum

MISCELLANEOUS FORMS
- Damage report
- Watchman's report
- Goods returned
- Accident report
- Outside work, no material
- Outside work, material charged
- Departmental correspondence
- Departmental requisition
- Inspector's memorandum
- Foremen's punches

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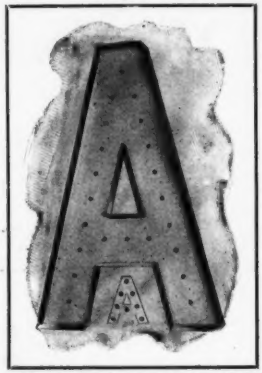

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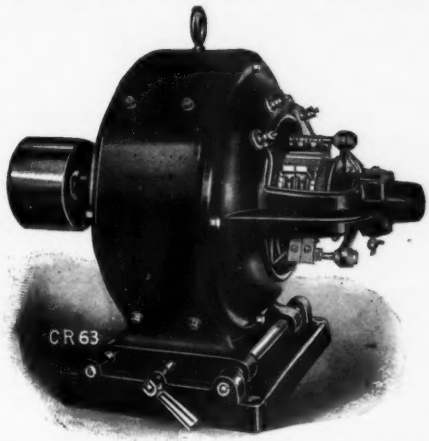

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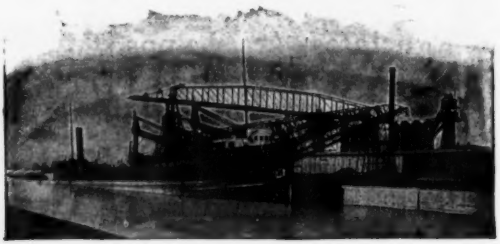

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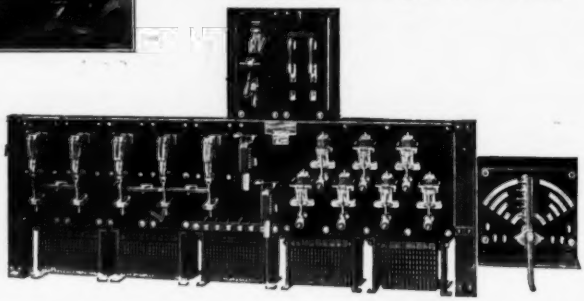

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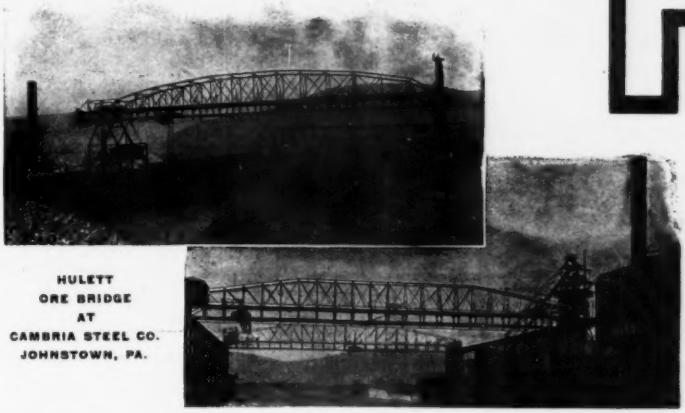

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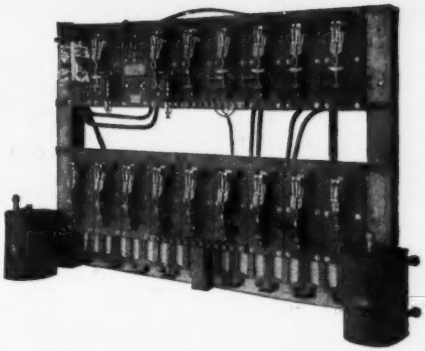

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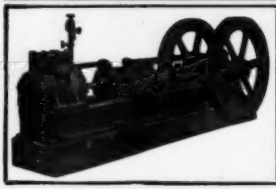

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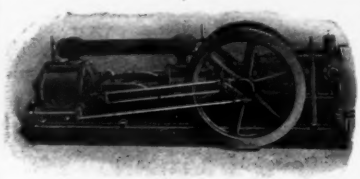

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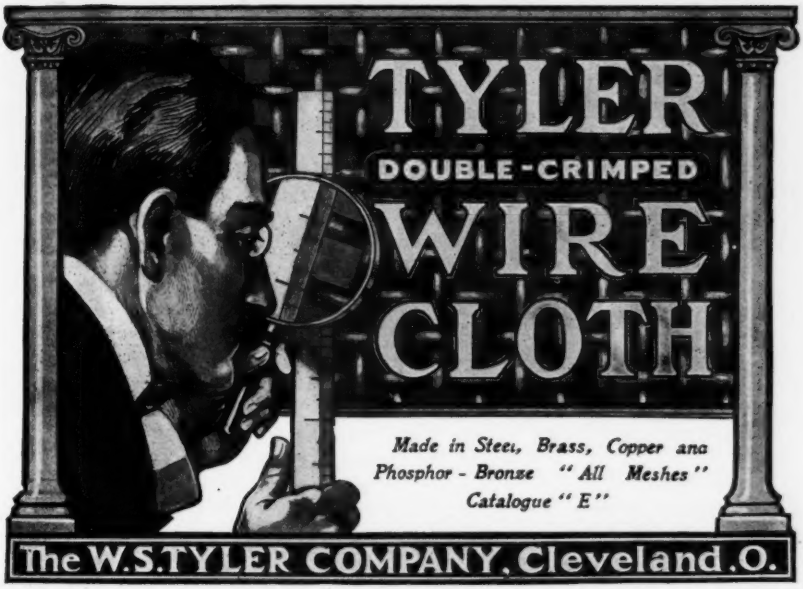

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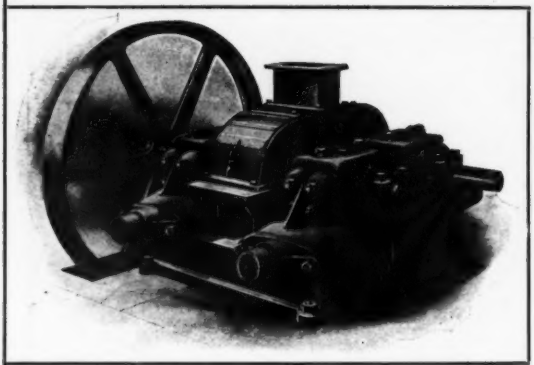

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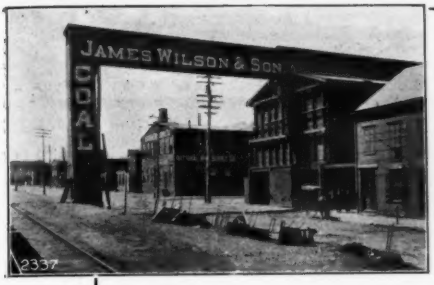

RETAIL COAL POCKET

Installed for James Wilson & Son, Paterson, New Jersey

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No plant is too small for the consideration of modern methods of Coal Handling

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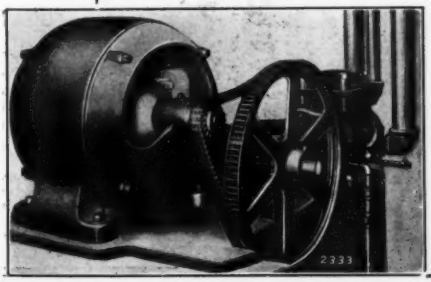

RENOLD SILENT CHAIN

Drive from 3½ H. P. motor to pressure pump

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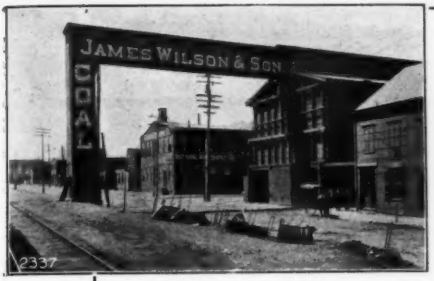

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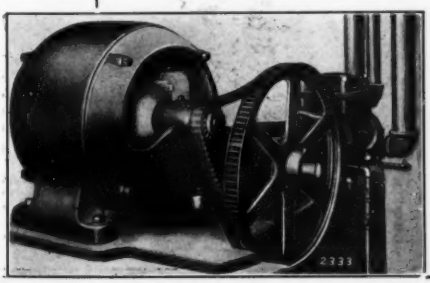

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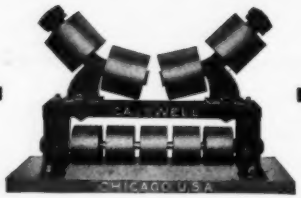

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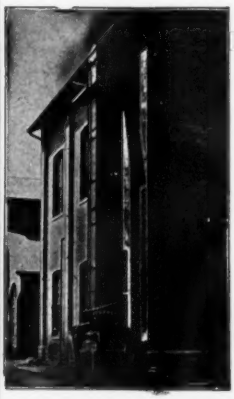

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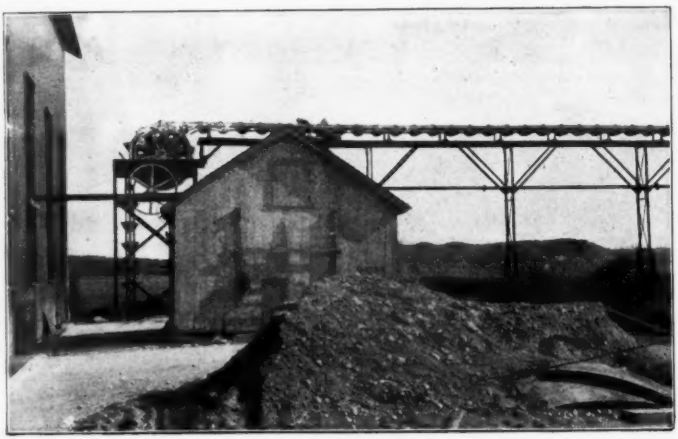

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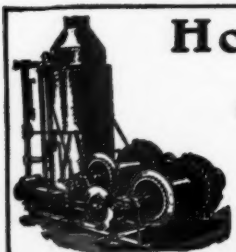

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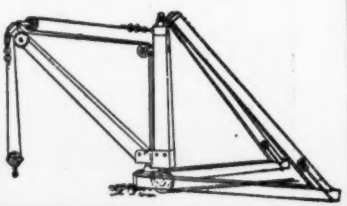

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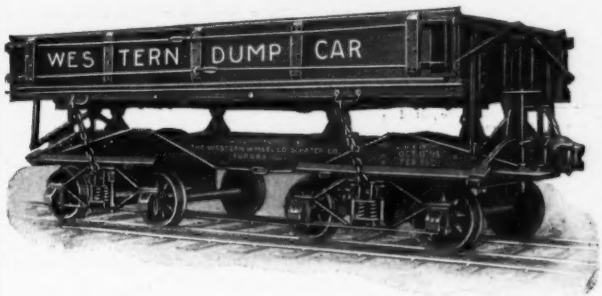

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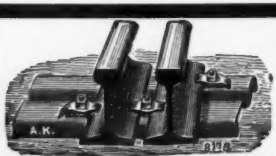

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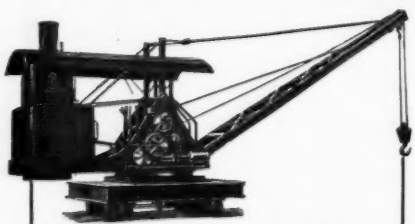

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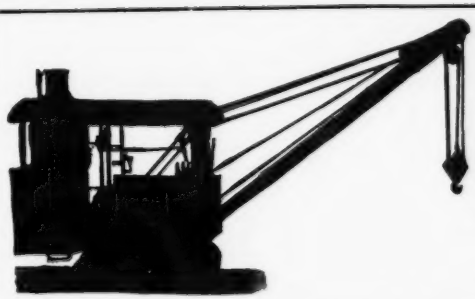

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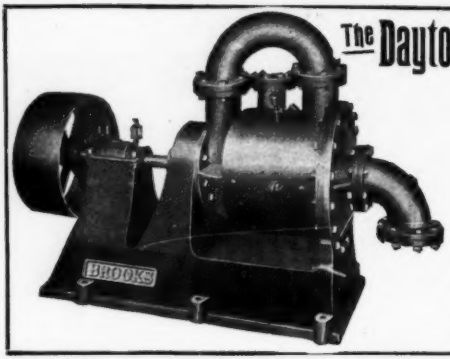

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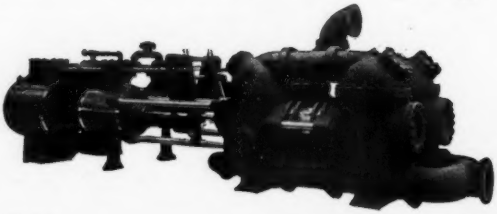

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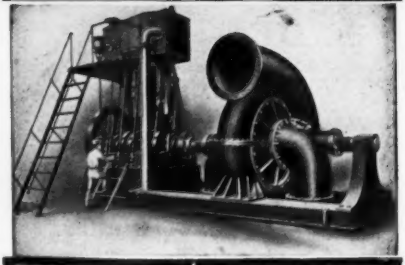

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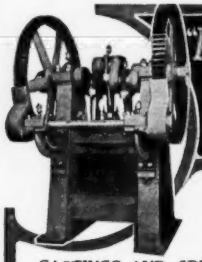

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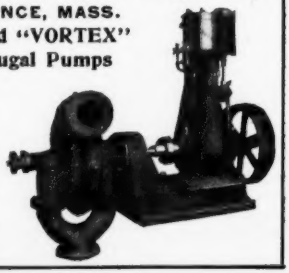

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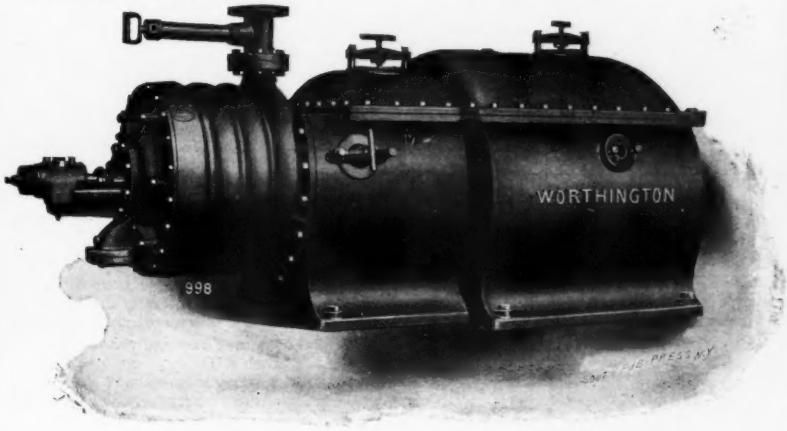

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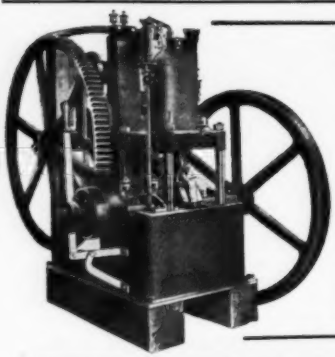

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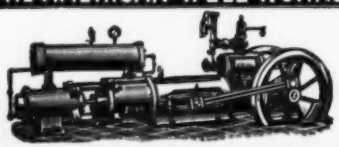

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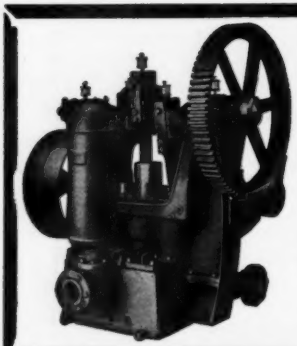

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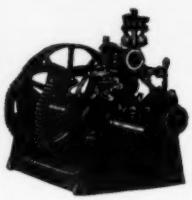

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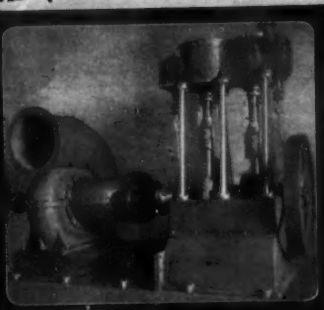

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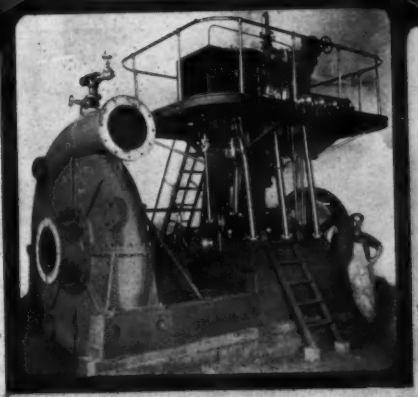

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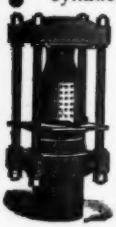

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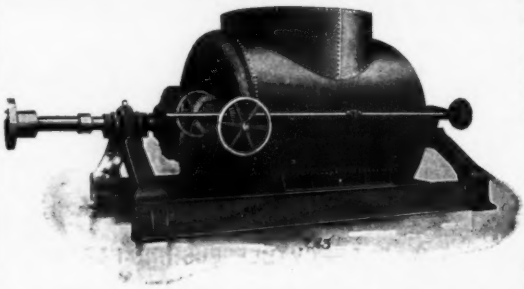

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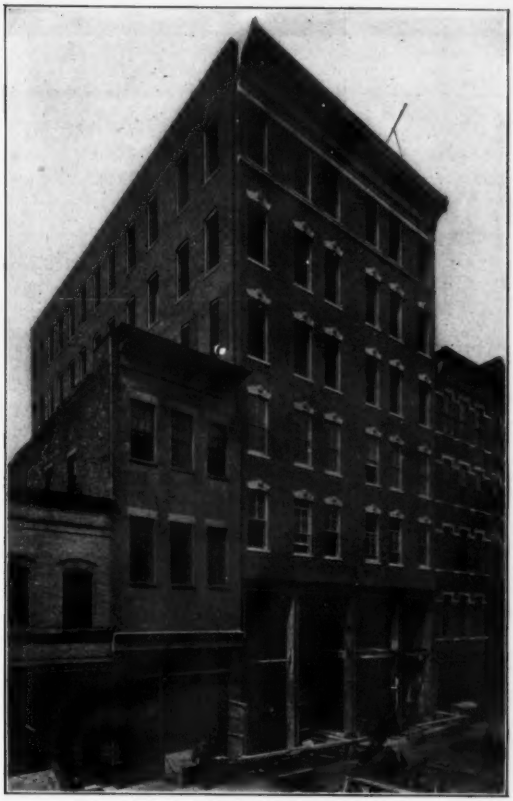

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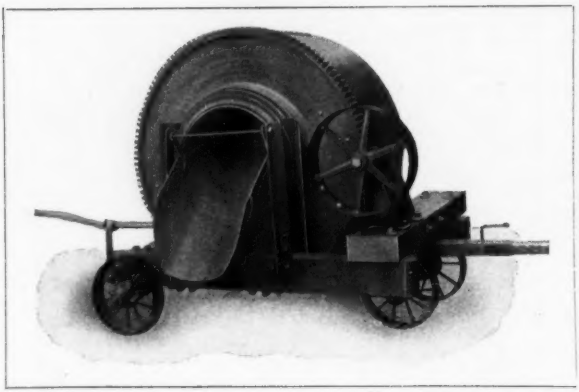

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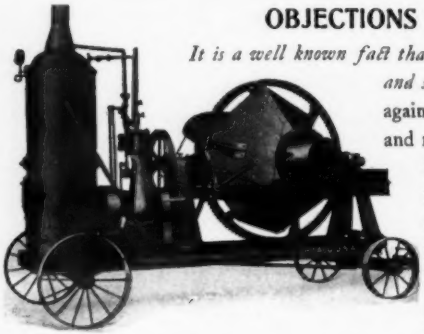

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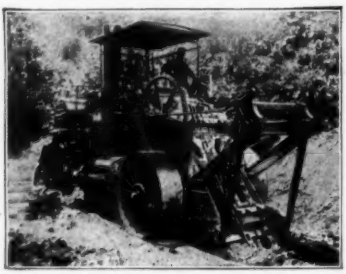

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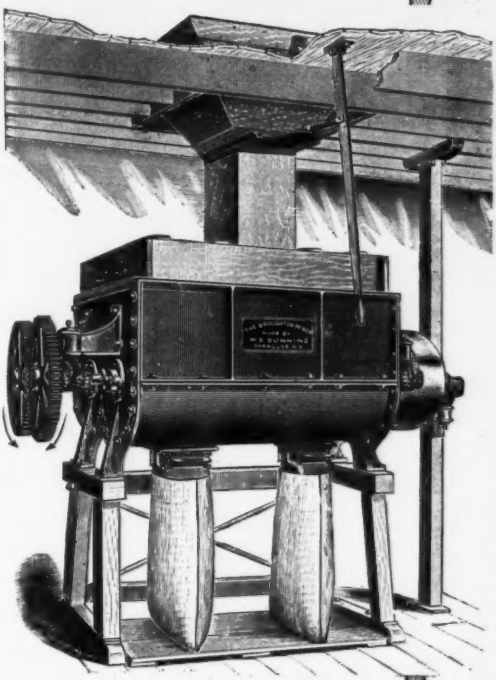

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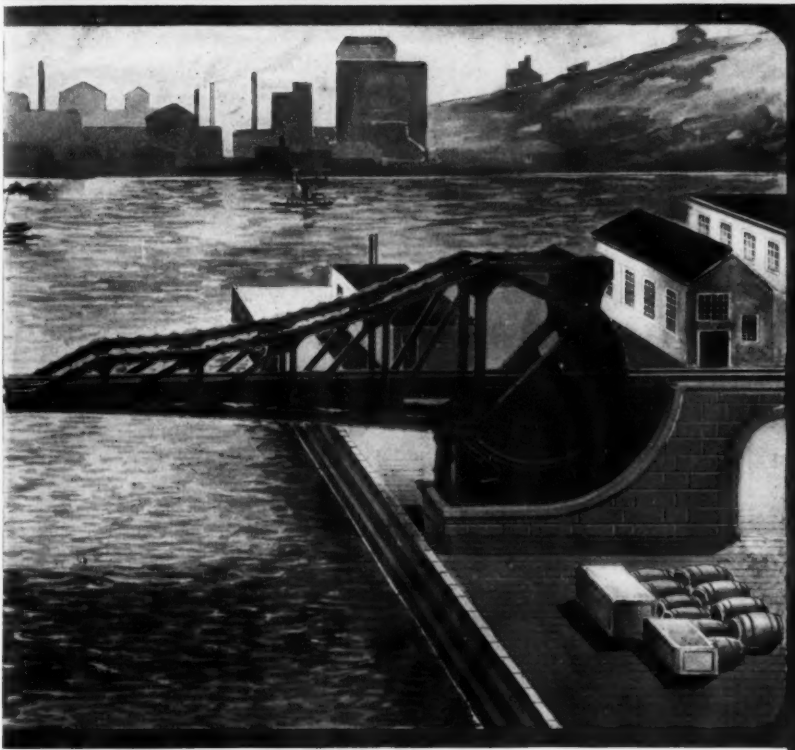

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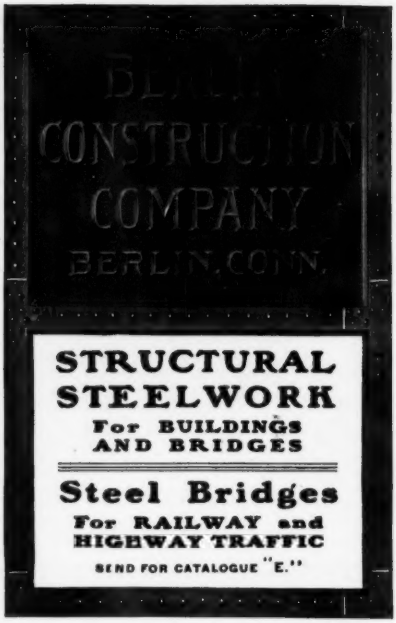

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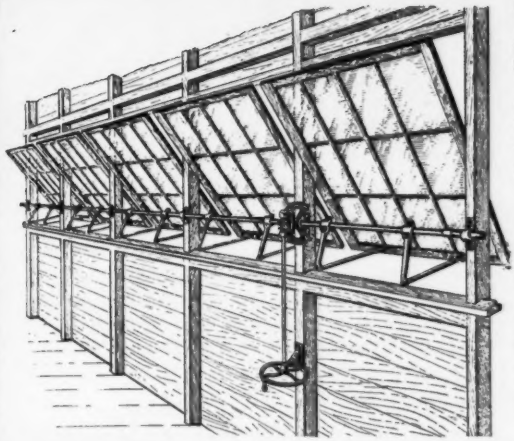

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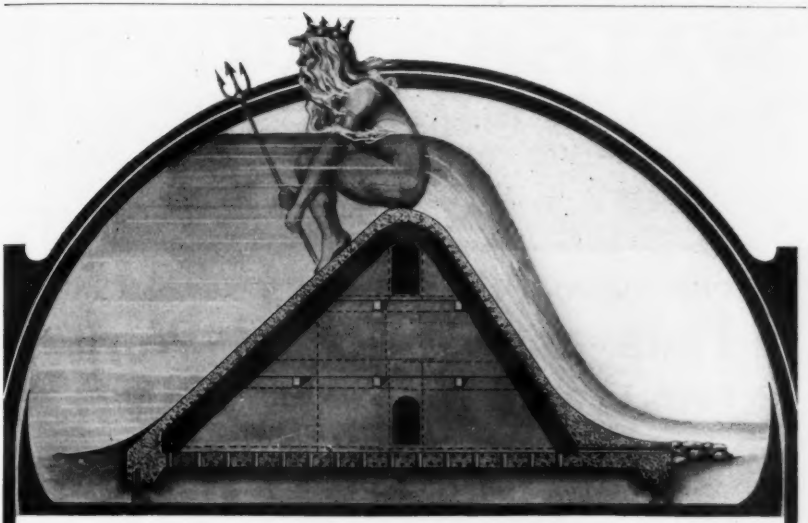

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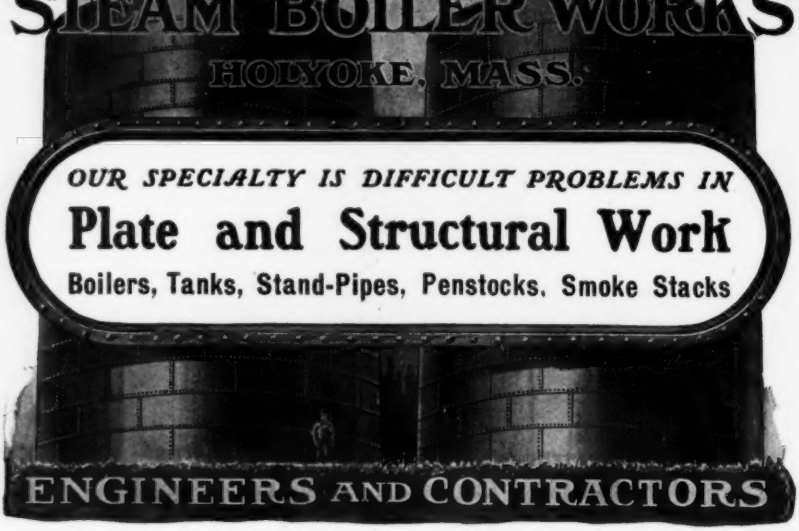

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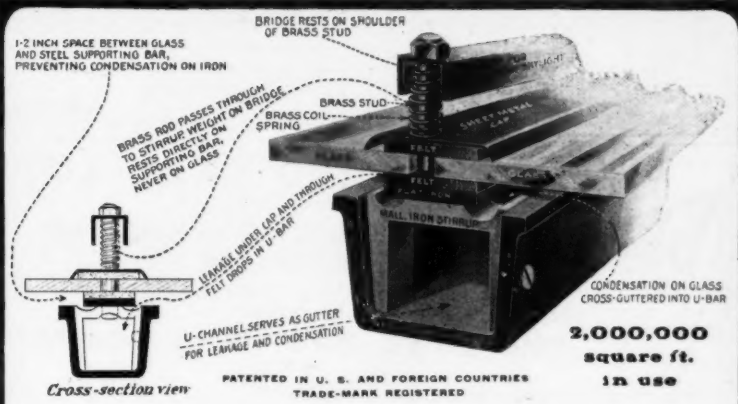
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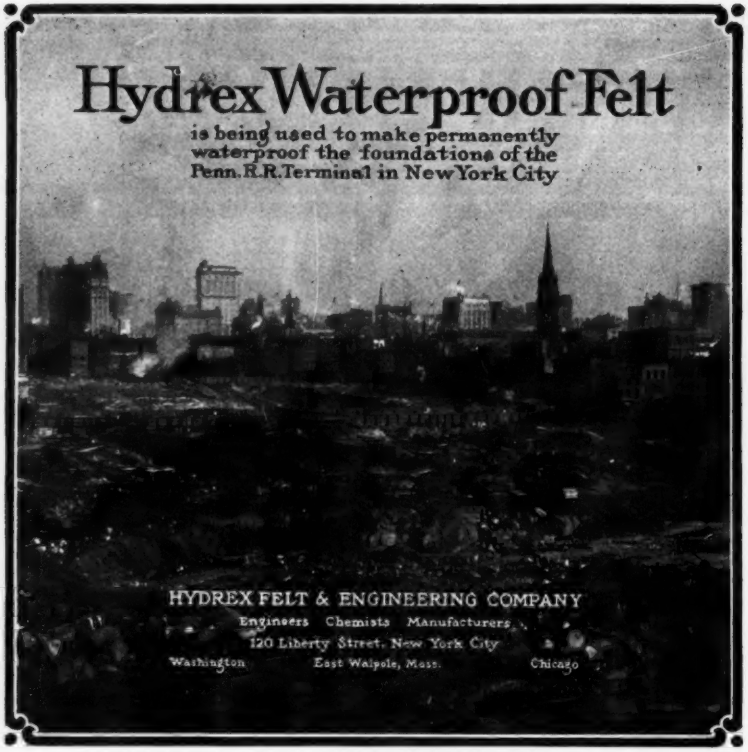
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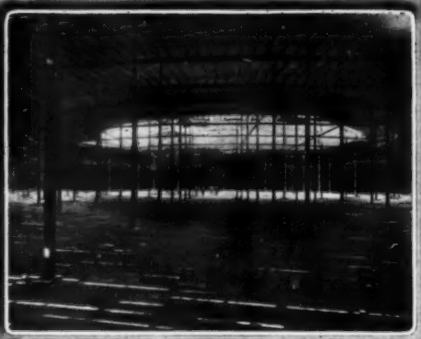

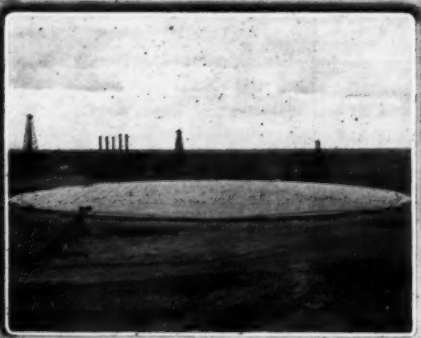

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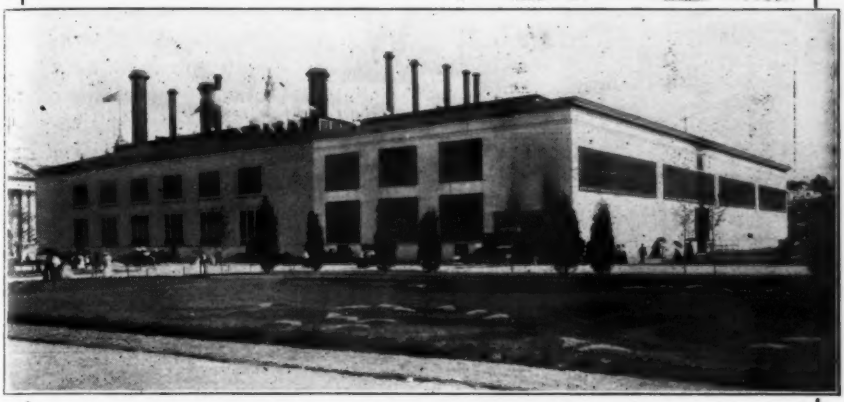

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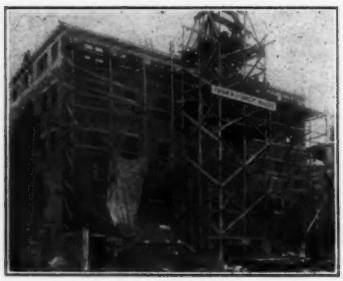

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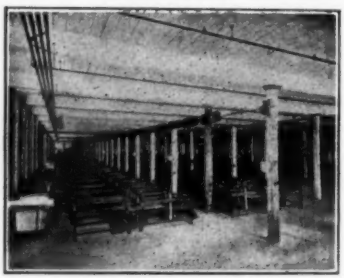

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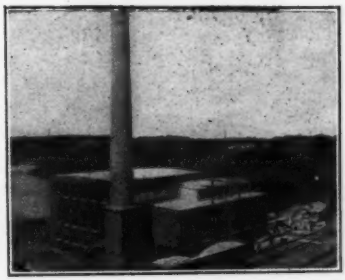

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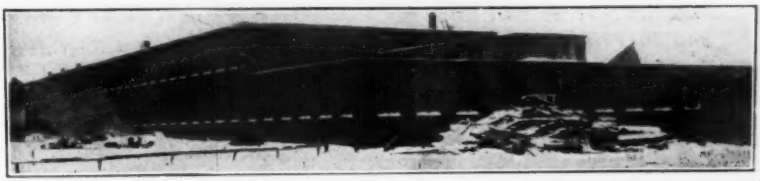
the question of the loop holes in the lump sum contract—and the number of these loop holes is legion—let us consider what the owner pays for this form of contract. The lump sum contractor won't work without a profit any more than we will; but he is taking the risk of unfavorable circumstances and he adds a good stiff percentage so that he will be sure, no matter what happens, of making his profit. Generally the unfavorable circumstance does not develop and the contractor naturally pockets the difference saved. That means two profits. He also saves the money which may accrue through the fortunate circumstances which are just exactly as apt to happen as the unfortunate ones. That would mean three profits. We solicit an opportunity of presenting the details of our system in person. We have explained these details to a good many men who have not become clients. We never explained them to any man, whether he became a client or not, who failed to express satisfaction with the investment of time he had made in studying our system with us.



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Further information and particulars may be had by applying to Frank P. Hakes, Trustee, Cortland, N. Y., or George S. Tarbell, Referee, Ithaca, N. Y., or Messrs. Choate, Hanford & Larocque, 40 Wall street, New York City, or Messrs. Kellogg & Van Hoesen, Cortland, N. Y.

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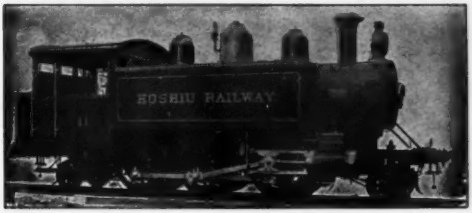

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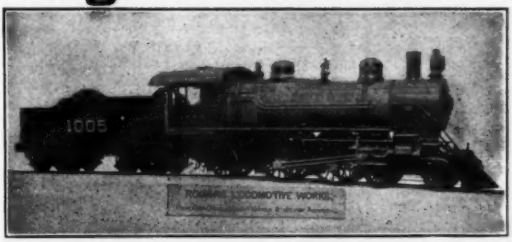

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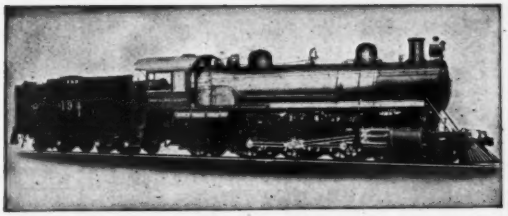

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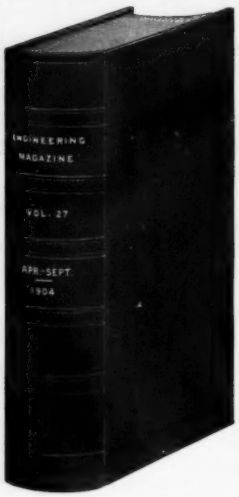

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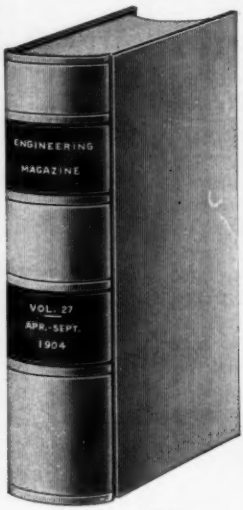

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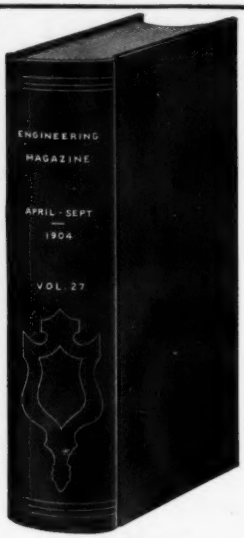

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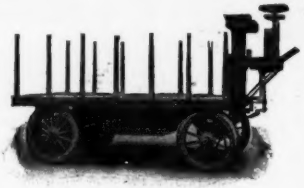

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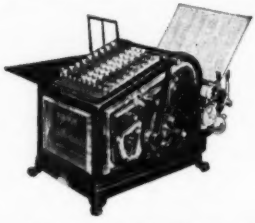

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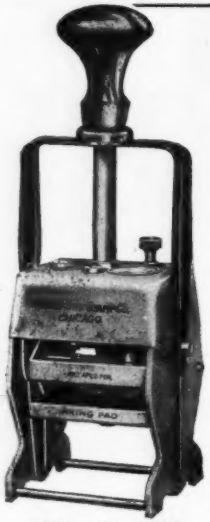

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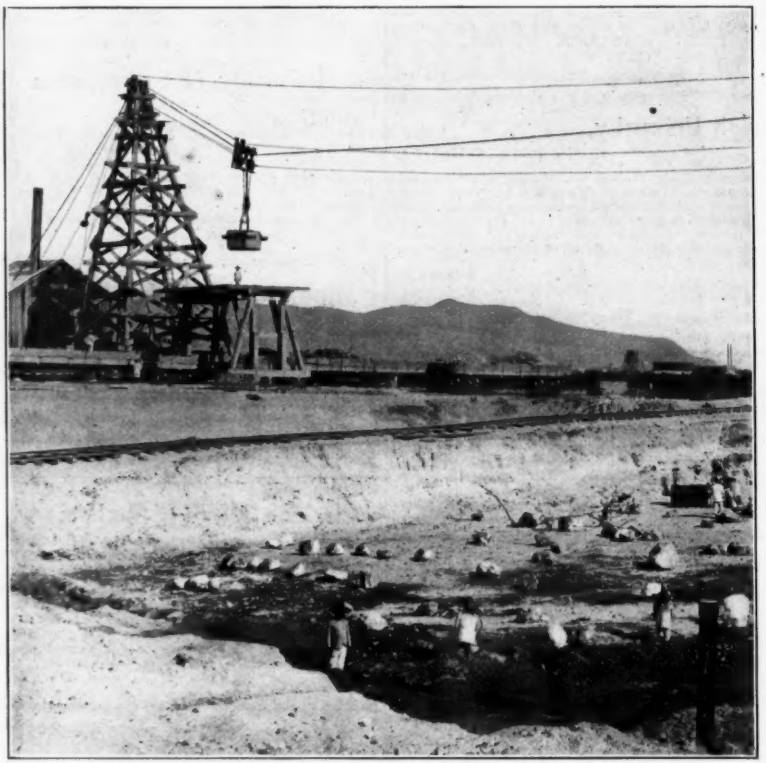

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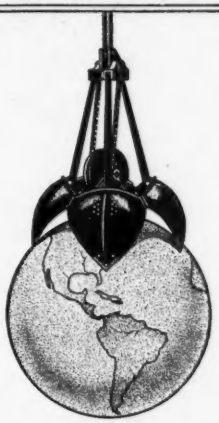

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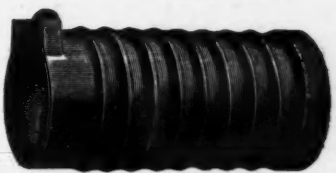

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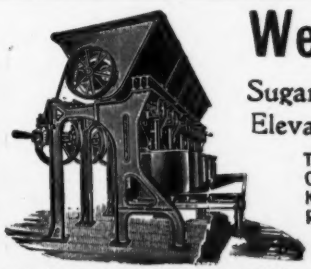

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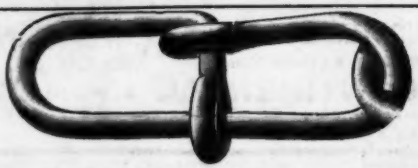

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